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THIS issue is so well able to speak for itself that we shall let the contents (left) do all the summarizing—with only a comment apropos of the tribute to DR. KASTER (p. 42). Any man who is big enough to deserve the encomiums of his profession is also big enough to know that his work is good. But, withal, he is human enough to be made happier by expressions of appreciation, confidence, and friendship given him while he is living. This might not be true if he were certain he would hear and know about those given him after he's gone. But he isn't certain, and neither is anyone else! There is such a finality about death! No proof of anything beyond it; only faith with which to wait its coming. That, however, may have been designed as an element of our humanness. Either way we prefer to speak while the ear can hear, and appreciate while the heart can understand. It must be comforting to the Santa Fe surgeons that, three years ago, they had DR. CLINTON say what they thought. . . . DR. CLAY RAY MURRAY asks us to note in this issue, as we should have in the last, that his "Fractures of the Leg and Ankle" (December, p. 711) was only the stenographic report of a talk informally and rapidly given. The reactions to the printed form, however, have been unanimously favorable. The forcefulness with which DR. MURRAY spoke brought to our readers a reflection of the dynamic personality with which his friends and associates are so familiar in their contacts

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The Science, the Law and the Economics of Industrial Health

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The Etiology of Lumbago and Sciatica

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NO OTHER problem lends itself more to speculation and conjecture than does the etiology of lumbago and sciatica. Yet in spite of this there are relatively few theories attempting an adequate explanation of these economically important entities. The very fact that these theories are few does not indicate that the medical men are perfectly satisfied as to their adequacy, but on the contrary the majority of us have accepted them with our "fingers crossed," hoping that such explanations are not subjected to any degree of scientific searching.

In the United States and Canada the general consensus of opinion is that both lumbago and sciatica are due to pathology within the sacro-iliac, the lumbosacral or the lumbar articulations and for a good measure, or as a means for variety, a sprain in the lumbar musculature. The latter is especially a good etiology if the patient is a potential recipient of compensation.

Some claim that there is no relationship between the lumbago and sciatica and will state that lumbago is a sprain of the soft tissues, whereas sciatica is a referred pain resulting from some injury to one of the various articulations comprising the back and pelvis. Were it possible to demonstrate the alleged pathologies of sprains it would be an easy matter to prove or refute such contentions. However, on the basis of history alone, one is quite tempted to place these two entities as well as one or two others in the same category. Church and Peterson[1] in discussing sciatic neuritis state: "In quite a proportion of cases there is an antecedent lumbago." And it is also true that a diagnosis of traumatic lumbago is frequently changed to sciatic neuritis, after the development of symptoms compatible with a diagnosis of sciatica has taken place.

Willis[2] emphasizes the importance of hereditary structural defects as a basic cause for lumbar disturbances, saying that "The human back is particularly subject to aches of muscle, joint and ligamentous origin because of its complicated structure, its adoption of the upright posture, and because of frequent defects of development in the lumbosacral area, some of which are serious mechanical faults."

While it is true that a certain small number of so-called lumbagos that one sees are due to an aggravation of some pre-existing mechanical fault in the human structure, these are by no means an important entity in so far as differential diagnosis is concerned, inasmuch as these can be readily ruled out by means of a competent postural and x-ray examination. On the other hand the transiency with which lumbagos and sciaticas occur rules out developmental defects by virtue of such defects being constant factors, and it is inconceivable that they can cause lumbago one week and give absolutely no trouble a week later. It is, therefore, important that presence of developmental defects and a history of progressive disease be shown before a diagnosis can be based on the presence of these anomalies. The mere presence of an anomaly does not constitute a basis for such diagnosis, especially if the patient had been symptom free prior to an abrupt onset and particularly so if recovery is obtained through no other than symptomatic treatment.

That developmental defects and other entities causing a deviation from a normal curvature of the spine rarely cause an acute attack of lumbago is well brought home by the fact that patients with tubercular spines, though frequently badly deformed, seldom complain of pain. It can be granted that a progressive pathological condition such as cancer or proliferative arthritis does cause pain; but here again the mechanism of pain production is obviously not related to any muscular imbalance.

Proponents of the theory that sudden lumbar pain, coming on while the patient had lifted a weight or had merely bent over to lace his shoes, is a result of a sprain of the soft tissues, fail to be more specific and if really pinned down to it cannot locate such lesions.

Key and Conwell[3] define a sprain as: "A temporary subluxation in which the articular surfaces have returned to normal position, and in which there has resulted more or less damage to the ligaments, tendons and muscles around the joint." One can visualize such a condition occurring occasionally without the production of ecchymosis. On the other hand, the frequency with which one meets "sprained backs" and the absence of extravasation in all these cases tends to dispel any notion one might have had with regard to even a remote possibility of a sprain. It may be argued that the lesion is a deep-seated affair and that the deep lumbar muscles hide the presence of blood, but this cannot hold in view of the fact that in all injuries of this type, the blood would gravitate along the fascial planes and would manifest itself over the sacral region. Certainly such a manifestation would be expected in at least the more severe cases of "sprain." It seems that the term "sprained back" is used rather loosely and certainly without reference to any pathological findings. The term is, therefore, a misleading one and is in all probability used to cover up ignorance. If one must really give a diagnosis in a case of this type, certainly the old term "lumbago" is more desirable, inasmuch as it indicates a presence of pain and does not attempt to establish a pathological condition. Irrespective of which diagnosis is made, the patient's condition will improve only if adequate therapy is instituted, but the question of financial responsibility is often jeopardized by a snap diagnosis especially with reference to a practically non-existent "sprained back."

McMaster[4] points out that muscles rupture only in contracted state when such ruptures are incurred by indirect violence. He does not believe that normal muscle can be ruptured in the resting state. He also points out that ruptured muscles are accompanied by pain, discoloration and swelling. His conclusions entirely rule out the possibility of a "sprained back" being acquired in the act of bending over as so many of our lumbagos occur, for in this position all the lumbar muscles dorsal to the lumbar vertebrae are relaxed, and if such a rupture were accomplished, discoloration and swelling would become apparent.

It must be conceded however, that such ruptures and discolorations can take place if the patient be exposed to some outside force such as getting hit by a falling weight or by falling down, but in these the pathology is obvious, the history is definite, and anything may happen. But we are dealing with spontaneous conditions that arise without external violence; conditions in which the physician listens to the history, examines the patient and then wonders whether to call it lumbago or a "sprained back."

Williams and Yglesias[5] present evidence that both lumbago and sciatica are caused by the mechanical irritation of nerve trunks due to loss of the lumbosacral disc which causes a narrowing of the intervertebral foramen. This sounds interesting, but they do not explain why lumbagos and sciaticas are subject to sudden remissions, and why spontaneous "cures" are obtained in such a large majority of cases. To substantiate their contention they go further than that; they say that the irritation in cases of sciatica is almost invariably confined to the root of the fifth lumbar nerve. This is an interesting point, as will be seen later in this discussion. These authors cite cases in which operative procedures to remove these mechanical defects had resulted in immediate and consistent cures.

Heyman[6] describes an operation in which the posterosuperior spine and the lateral aspect of the posterior third of the ilium are completely denuded of ligamentous as well as muscular attachments. He describes two cases of sacro-iliac pain cured dramatically by this procedure. The important feature of his work is that the stripping of ligamentous and muscular attachments *gave* immediate relief. While he fails to prove that the mechanical irritation is the cause of such conditions he does prove that small ruptures of ligaments or muscles are not a factor in pain production, further showing that "sprained backs" are not a true entity.

Other authors have obtained good results by sectioning the tensor fascia lata, although they admit that the rationale of the operation is one to be questioned.

THE following case presents some interesting features of lumbago associated with sacro-iliac pain:

CASE 1. Mr. L., a white male clerk, aged 53, developed a sudden severe pain in the mid-lumbar region while he was at work; there had been no strenuous or unusual effort. He attributed his pain to a "cold in the back." This pain continued with varying severity and intermittently for a period of two weeks before he consulted this clinic. On admission he stated that his pain is excruciating in character, but intermittent; he was unable to say how long an attack would last, but he did suffer daily. At times he would wake up without any pain and would continue symptom-free for several hours. Suddenly he would be seized with a sharp pain, and he would be unable to move without agony. Adhesive strapping and sodium salicylate relieved the severity of the attack but did not give complete relief. Physical examination was negative except for a spastic limitation of motion involving the lumbar region, and a suggestion of gingivitis. There were no deformities. X-ray of the teeth showed a suspicious periapical infection about several of the teeth. X-ray of the back and pelvis showed a lipping of the first, second, and possibly fifth lumbar vertebrae; there was some lipping at the left sacro-iliac joint.

Urinalysis was negative.

Heat and massage were applied. These treatments gave him temporary relief only, and it was necessary to administer codiene for the relief of some of the severe attacks. At this time it was thought advisable to administer acetyl-salicylic acid, but the patient informed us that he was allergic to aspirin and the idea was dropped.

Infra-red and massage were continued for six weeks, being given every two or three days. At the end of this time diathermy was instituted but was discontinued after two weeks and infra-red was resumed for another two weeks. Up to this time he had done nothing with regard to his teeth and was still unimproved.

On arriving home from work after being relatively free from pain all day, he was seized with a terrific pain in the left lumbar and the left sacro-iliac region. His wife found some "pain killing" tablets in the house and gave him two of them. Within five minutes after taking them he realized that they contained aspirin. His face became flushed, his body developed red blotches and he was barely able to breathe. A physician was summoned but upon arrival the patient had regained confidence and although still suffering from "shock" was content to remain without medication. The following morning he had recovered from the allergic reaction and there was no pain in the back. Six months following this episode he was still free of pain in the back.

The history in the foregoing case, though typical, rules out the possibility of trauma as the etiological factor. The x-ray findings would tend to substantiate the theory of mechanical irritation were it not for the fact that a spontaneous cure had ultimately been obtained. The method of cure though quite accidental and empirical is more or less conclusive that the symptoms were not produced by any mechanical pressure, but were in all probability a result of some disturbance in the peripheral circulation which was relieved by a general peripheral vasodilatation.

It is nothing new to suggest that focal infections play an important part in the production of lumbago and sciatica, but just how this infection will produce pain at a remote site is difficult to explain. However, on the basis of our present knowledge, we must assume that the probable mode of action would be either through emboli being carried by the circulatory system and lodging as a new focus in a remote capillary, or the toxin liberated by such foci may act on the autonomic system and thereby produce symptoms in some area remote to the infection.

Whatever the mechanism of pain production is, it is not thoroughly understood, but Lund[7] says that "When an embolus lodges the first reaction is an intense spasm of the arterial tree in the whole region supplied by the vessel . . . In any case the spasm passes off after a shorter or longer period of time. The intensity and duration of the spasm are variable and enter into the picture and prognosis of all these cases." Is it not possible then that the acute symptoms in the lumbar, and the sacro-iliac regions are a result of such emboli? Or is there vasospasm resulting from some hitherto unexplained action of toxin on peripheral blood vessels?

Reid and Herrman[8] suggest a possibility of this, saying that "Observations are accumulating which seem to justify the belief that the vast majority of our serious problems of peripheral vascular diseases result from a speeding up of the usual slow progressive occlusion of vessels or from an insult through trauma, *infection or cold*, which throw not only an acute strain on the collateral vessels, but induce a period of vasospasm."

Just how "infection or cold" act they do not attempt to explain, but it must necessarily be either through toxic or embolic stimulation. They add: "The irritation of sensory sympathetic nerve fibres is probably the point of origin of the different impulses which cause the marked vasoconstrictor reflex. The motor impulses then cause a constriction of the diseased vessels from which the reflex arose, a result of no great importance, but they also cause a constriction of the anastomotic and terminal arteries."

In his discussion on arterial emboli, Lund cites a series of cases—two of which are particularly interesting. Case No. 7 in his series was a woman who developed a "severe pain like an electric shock," and was found to have had an arterial embolus. Of greater interest is his case No. 14, who gave a history something like this: "History began three months before with cellulitis of the right forearm; later he had a sudden cramp-like sensation around his right hip which spread down his ankle. This passed off gradually in the course of a month."

Both of these cases were definitely proved to have arterial emboli, and both describe their pain in terms so typical of lumbago and sciatica. The peculiar "electric shock-like" pain has been described in connection with lumbago for years. The German name for lumbago, "Witches' Shot," is probably the most descriptive term for this condition.

Those of us who have applied pressure over the olecranon know that pressure on the nerve does not produce a pain characteristic of the type associated with lumbago or sciatica.

Sudden obliteration of arteries would be a difficult experimental procedure to undertake in the human, yet Craig and Knepper,[9] in describing the symptoms produced by the compression of the subclavian artery by the scalenus anticus muscle, give us a typical picture. "The subclavian artery will be seen lateral to the scalenus anticus muscle, and it usually is compressed against the trunks of the branchial plexus. There were no sensory changes but a definite sharp pain extended down the right arm to the fingers when the patient flexed his head on his thorax. The radial pulse was obliterated bilaterally on extension of the head with deep inspiration."

IF OBLITERATION of the blood supply with ensuing vasospasm is to be accepted as a possible etiology of lumbar and sacro-iliac disease, it will be necessary for us to examine all of the findings in these cases and see whether or not they fit into a picture presented by embolic or spastic disorders. In order to accomplish this, it is necessary to compare the known factors in lumbago and sciatica with those findings in circulatory occlusion with which we are familiar.

The onset of lumbago and sciatica is sudden and corresponds to the onset described in cases where arterial embolism had taken place. The pain in both is described in similar terms and the variability of duration, severity and distribution is also similar.

Several authors have shown that there is a marked lowering of temperature in an area immediately surrounding an occluded or spastic vessel. This is also found in sciatica by Church and Peterson, although they attribute this fall in temperature to a trophic disturbance in the sciatic nerve itself. Whether or not the temperature in the region affected by sciatica would respond to peripheral vaso-dilation produced by intravenous foreign protein has not been shown, but if sciatica is caused by a vasospastic condition then the temperature should return to normal and the patient should be symptom-free for at least the duration of the vasodilatation.

It is true that sciatica never manifests itself by the presence of gangrene as do emboli of the arteries in the extremities, but this is probably due to the distribution of collateral circulation. We do know that not all embolic or vasospastic conditions result in gangrene.

It has been previously suggested that the sciatic pain is peculiarly limited to that area of the buttock and leg supplied by that portion of the sciatic nerve which emerges through the fifth intervertebral foramen. Would it not be equally true if we said that such pain is limited to that area supplied by the blood vessels emerging through the sciatic notch?

If we assume that vaso-spasm is responsible for sciatic and lumbosacral pain, it would be necessary to offer some explanation for the relief of pain obtained through the various surgical procedures attempting a cure. Harris[10] in discussing sacroiliac disease states that in 83.6% no evidence of pathology or mobility was found, yet of these 83.6% approximately 87.5% were benefitted by a fusion operation. In three cases where a return of signs and symptoms warranted a refusion, it was found that the primary fusion was solid and allowed of no motion, yet following this refusion the patients were free of pain. He admits his inability to explain this discrepancy.

We must remember that in cases where arterial emboli are demonstrated and removed, all pain disappears whether or not complete recovery of circulation had taken place.

Leriche[11] believes that most of the beneficial results obtained in arterial embolectomy are due to the localized sympathectomy operation, which is practically done during the arteriotomy procedure. Is it not possible that the operation described by Heyman, the fusion accomplished by Harris, the section of the pyriformis by others, and all other major procedures actually accomplish a local sympathectomy by virtue of their extensive incisions into the affected area? That seems to be the answer as to why relief is obtained in a majority of the cases operated on. Would not operative measures aimed at sympathectomy bring forth a higher percentage of cures? Sympathectomies undertaken for relief of pain in cases of vasospastic arterial disease in the extremities result in adequate relief, and would be of infinite value in long standing lumbagos and sciaticas if the foregoing theory is to hold.

While no data are as yet available on results obtained from such sympathectomies, it is interesting to note what Schmitter[12] has to say: "Williams says: 'I have seen a case of the latter character (sciatica) which has persisted for years in spite of continuous treatment, disappear as if by magic after laparotomy and the separation of the adherent appendages from the posterior and lateral portions of the pelvic wall.'

"In recent years there have been numerous reports on the relief of pain in the pelvis and the lower extremities, by the excision of the superior hypogastric plexus, also called the presacral nerve. This seems to throw some light on the relief of pain in gynecological operations in which sympathetic nerves are severed."

CONCLUSION: There is strong evidence that lumbagos and sciaticas are a manifestation of a vasospastic disorder, and should be treated as a circulatory disturbance rather than an orthopedic entity.

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DR. C. F. N. SCHRAM, Medical Director, Tennessee Eastman Corporation, writes us: "I would request that you announce the Southern Safety Conference meeting which is to be held in Jackson, Mississippi, on February 16-17, 1939. The Program Committee has recognized the value of industrial medicine in any efficient industrial safety regime, and has invited physcians to participate. DR. J. R. GARNER, Chief Surgeon of the Atlanta and West Point Rail Road Company, Atlanta, Georgia, is to speak in the afternoon session (February 17) on the topic "Industrial Medicine for Large and Small Plants," and DR. DONALD M. SHAFER, of the National Association of Manufacturers, will speak at the physicians' banquet that night. Every physician in the south who is doing any industrial work should attend these sessions."

Chronic Traumatic Ulcer

— of the Lower Extremity —

—Treatment with Acetyl - Beta - Methylcholine-Chloride (Mecholyl): (Case Report)—

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DURING the past two years, we have had the opportunity of observing and treating a patient who developed ulcers of the left lower extremity following an injury. He had had several surgical procedures and had used a large variety of therapeutic ointments and lotions prior to the time he first came under observation (August 20, 1936). Despite this intensive therapy, the ulcer over the lateral malleolus failed to heal. As a result of the extensive and frequent plastic operations performed, the blood and nerve supply to the local tissues were interfered with. The tissues contiguous to the ulcer area were therefore devitalized, markedly pigmented and scarred. We are reporting this case because following the use of Mecholyl* by iontophoresis, the ulcer closed completely and has remained closed for the past six months.

Case Report

R. P., a 35 year old white man, was employed as a manager of a chain grocery store. In February, 1931, he was "standing on an egg box packing cans on the top shelf of a food display." The top of the box collapsed and "the left foot and leg went through it." The skin on both sides of the left ankle was grazed. He painted the broken skin with tincture of iodine and returned to his work. Several days later he complained of pain in the injured extremity and noticed redness and swelling about the ankle joint. In March, 1931, (one month after the accident), he noted several small discharging sinuses about the injured area and consulted a physician. In November, 1931, (10 months after the injury), the swelling and discoloration about the ankle increased and "within a couple of days developed ulcers" over the lateral and medial malleolli of the left ankle. The ulcers were treated with a variety of ointments, lotions and bandages for the next four years, but failed to show any tendency toward healing. In May, 1935, for the first time since his injury, he was removed from his occupation and admitted to a hospital. On admission he had an ulcer just below the internal malleolus, about the size of a ten-cent piece. A tubular graft operation was performed at this time in an attempt to close the ulcer over the lateral malleolus. In September, 1935, he was admitted to the hospital for a second time. This time an excision of the entire ulcer and a Tiersch graft were performed. For about a month the graft closed the ulcer bed but then the ulcer recurred. The ulcer over the medial malleolus closed while he remained in bed in the hospital but the one over the lateral malleolus broke down repeatedly. In November, 1935, a pedicle flap was done in an attempt to close the ulcer over the lateral malleolus. Again the ulcer recurred. During December, 1935, and January, 1936, numerous pinch grafts were performed. The ulcer recurred. The patient is married and has two living children. The past history was essentially negative. Fourteen years before the onset of the present episode, he was operated on for ruptured appendix with localized peritonitis. He made an uneventful recovery. He denied venereal disease.

Physical examination revealed that the patient was a white adult male, 35 years of age, 5 ft. 11 in. tall, weighing 155 lbs. Examination was entirely normal, with the exception of the left lower extremity. The right lower extremity was normal with the exception of a large scar on the lateral aspect of the thigh, which marked the site from which the tubular graft was taken. Over the lateral aspect of the left leg there was a linear scar about 8 in. in length. There was another scar over the left thigh. These were the sites from which tissue had been removed for plastic operations. On removing the dressing from the ulcer bearing area, one noted that the dressing was covered with a thin, greenish, gelatinous, purulent exudate. There was an indolent ulcer directly over the lateral malleolus which measured 2½ in. in transverse diameter and 1½ in. in the horizontal axis. It was irregular in outline with raised, thickened and discolored edges. The ulcer was filled with the same purulent discharge that was noted on the dressing. Its base was unhealthy looking and was about ⅛ in. below the level of the edges. The skin surrounding the area was discolored with a dark brown pigment and was edematous. The entire ankle area was warm to touch and presented evidences of inflammation. The dorsalis pedis artery pulsation was easily palpable but the posterior tibial artery could not be felt. Because of the intensity of the pain produced when the cuff was inflated, oscillometric studies could not be done on the affected side. Oscillometric studies on the unaffected side showed normal patency of vessels.

Laboratory Studies: Blood Wassermann, Kahn, and urine normal. Blood chemistry revealed the following normal values per 100 cubic centimeters of serum: Sugar—96 mgm.; uric acid—4 mgm.; creatinine—1.5 mgm.; urea nitrogen—13.6 mgm. Blood study revealed the following: Hemoglobin —78%; red blood cells—4,540,000; white blood cells—9,990; polymorphonuclear leucocytes—63%; lymphocytes—35%; monocytes—1%; eosinophiles —1%.

The patient was admitted to the hospital under our observation on September 9, 1936, and put to bed. The extremity was elevated. The photograph inserted (Fig. 1) was taken on admission to the hospital. September 12 he received his first iontophoresis treatment. Three days later the following note was made: "The base of the ulcer is clean and healthy looking. There is some evidence of beginning granulation tissue formation

* We are indebted to Merck & Co. for supplying this material.

just below the left lateral malleolus." Treatments were given every 48 hours starting with 12 milliamperes for 15 minutes and gradually increasing the duration of the treatment to 30 minutes and the milliamperage to the tolerance of the

Fig. 1. **Fig. 2.**

Fig. 1: Appearance of ulcer on September 2, 1936. The linear scar is at the site of an arterial sympathectomy. Fig. 2: Shows the scar on the right thigh in November, 1935, the site from which a graft was taken. The ulcer posterior to the medial maleolus had healed spontaneously in September, 1935

patient. Within two and one half weeks the ulcer measured 1 in. in its transverse diameter and 1 in. in its longitudinal diameter. Its base was

Fig. 3.
The healed ulcer over the lateral maleolus as it appeared December 14, 1937

raised to the level of its edges. Tongues of epithelium tissue could be seen extending in from the edges toward the center of the ulcer. The patient was discharged from the hospital and reported to the office three times a week for treatment. The progress was satisfactory until November 15, 1936, when it was noted that the ulcer had become refractory to treatment and did not diminish in size. In January, 1937, the patient was re-admitted to the hospital. Bed-rest was again enforced and the treatments were continued. On February 20, 1937, the ulcer was the size of a navy bean. On March 1, 1937, it was completely closed. The skin covering the ulcer was delicate. At this time it was noted that the skin about the ankle had lost its dirty brown pigment and was now pink and healthy looking. There was no edema of the soft parts about the ankle. The patient was discharged from the hospital on March 14, 1937, and reported for treatment at five-day intervals. On March 23, while en route to the office, he sustained an injury (kick) to the left ankle over the area of the ulcer. On examination within one half hour after the injury, a small superficial erosion about the size of a pinhead was noted over the center of the ulcer. Within five days the ulcer, which had closed, again broke down at the site of the "kick" and discharged a thin purulent material. The edges were thickened, edematous, discolored and unhealthy looking. Its base was about ⅛ in. below its edges. On April 5 the patient was re-admitted to the hospital, confined to bed, and mecholyl by iontophoresis continued. Within two weeks the ulcer was closed for the second time but the skin over the center of the ulcer was delicate and almost tissue paper in consistency. The patient became extremely restless at this time and refused to remain in bed. Within a week after he was up and about the ulcer again broke down. The base was indulent in appearance and the ulcer at the end of three months measured ½ in. in length, ½ in. in width. Its base was approximately $\frac{1}{16}$ in. below the level of its edges. On September 1, 1937, the patient decided to cooperate by remaining in bed until there was complete and firm union. After three months of complete bed rest and iontophoresis treatment every day, the ulcer closed (Fig. 3) and has since remained closed. For a period of six months after the ulcer was closed, treatment was continued twice weekly and the patient was not permitted to put any weight upon his left foot. During the past three months he has been up and about, using the leg freely without any support, and the ulcer has remained closed.

Literature

IN 1932 Major and Kline[1] synthesized acetyl-beta-methylcholine-chloride, and found it to be a more stable compound, free from the nicotine-like side effects of the previously known derivatives. The fact that mecholyl possessed all of the beneficial vasodilating properties of the choline derivatives and lacked the harmful nicotine-like side effects of these chemicals, made this new preparation a most valuable addition to the therapeutic armamentarium employed in the treatment of vascular diseases. A complete review of the literature dealing with the experiments performed to establish the full value of this chemical is not warranted in a report of this type. However, it has

been used with success in the following conditions: Paroxysmal tachycardia,[2] arthritis,[3 4] neurogenic bladder,[5] pelvic inflammatory disease,[6] chronic leg ulcers,[7 8] thromboangeitis obliterans,[9] Raynaud's disease,[10] early diabetic gangrene,[3] scleroderma,[11] atonic constipation[12] and abdominal distention.[13]

Technique

IONTOPHORESIS is the induction of ions through the intact skin by the use of a galvanic current. If pad electrodes are soaked in a diluted solution of a drug and connected to a source of galvanic current, the ions of the drug penetrate into the tissues under the effect of a suitable pole. The depth of penetration, according to Kovacs,[3] depends upon several factors. Among them are length of time the current flows, electromotive force, weight of ions and the type of tissue being treated. A 0.5% solution of acetyl-beta-methylcholine-chloride (mecholyl) is used. The drug being an alkaloid with a positive charge, can be introduced into the tissues only from a positive pole. A piece of gauze saturated with solution is employed to cover the ulcer. Reinforced asbestos fabric paper is saturated with the solution of mecholyl and wrapped around the affected extremity, covering it from the tip of the toes to the knee. A fairly large malleable metal plate is wrapped around the extremity in a spiral fashion over the wet asbestos paper and connected with the positive pole of the galvanic generator. Care must be exercised not to cross the ulcer bed with the malleable metal electrode. The entire extremity is then bound firmly with an ace bandage to insure contact. Care must be taken not to exert too much pressure however, because during the process of treatment, an increased blood supply to the extremity causes temporary enlargement of the area. A large, regular, moist pad dispersive electrode is applied to the back or abdomen and is connected to the negative pole.

The current is turned on and slowly increased to from 20 to 30 milliamperes, always being kept within comfortable tolerance to the patient. The duration of the treatment is 20 to 30 minutes. The treatments are best given in the recumbent position. To avoid the possibility of burns, care must be taken that the metal electrode or electrode clamps do not come in direct contact with the skin. When the treatment is completed, the milliamperage is reduced slowly and the current disconnected. The treated part is dried and the extremity should remain elevated for about a half hour.

Physiological Effect

LOCAL ACTION: The local effects include goose flesh, blushing, sweating, diffuse pinkness of the skin, increased local skin surface temperature and an increased feeling of warmth over the treated part. The local action lasts from 12 to 24 hours.

CONSTITUTIONAL ACTION: The constitutional effects include increased salivation, sweating, general feeling of warmth, fall in blood pressure, rarely a sense of heaviness across the chest and occasionally lacrimation.

Discussion

MECHOLYL by iontophoresis has been used with marked success in the treatment of obtinate varicose ulcers.[8] In the case here reported, we were dealing with an ulcer, traumatic in origin, located over the external malleolus, which had resisted all types of treatment including extensive plastic surgery. As a result of the surgical procedures the tissues were markedly impaired. The fact that this ulcer was directly over the malleolus was another factor which, in this instance, delayed healing. It would seem advisable in cases of chronic ulcer of the lower extremity to employ the use of mecholyl by iontophoresis before any surgical procedures are attempted.

In reviewing the literature we could find no mention of any case reports in which mecholyl by iontophoresis had been recommended for the ulcer due to trauma. In the case reported, after every scientific procedure had failed to bring about a cure, the ulcer was closed by the method described above. We therefore feel that this case merits being recorded in the literature.

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Example of an Installation

— for the Control of the Hygienic Exposure Arising from the Application of Pottery Glazes —

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ONE of the essential steps in the manufacture of the ceramic product, "Whiteware," commonly known as "Dinnerware," is the application of various types and compositions of glazes to give the vitreous or semi-vitreous ware a glossy, impervious, protective coating that will withstand the normal abuses met with in their utilization.*

As early as 1919, the U. S. Public Health Service in its study of the lead hazard[1] in 92 pottery factories in four states, found 139 cases of positive lead poisoning, 106 presumptive cases and 168 suggestive cases in a group of 1809 examined persons employed in glaze preparation, dipping, and in the glost department.

Recognizing the gravity of this problem, pottery management has exerted every effort toward controlling the lead hazard. Since the survey of 18 years ago, the plants are better housed and afford the worker much better sanitary facilities than had been provided before.

Fritted glazes, rendering the raw lead used relatively insoluble, are much more widely used. In a recent publication, Koenig[2] has reported more in detail upon the laboratory and plant tests of Frit Formulae intended to reduce the lead exposure of pottery workers.

Methods of "good housekeeping," even to the extent of vacuum cleaning, are finding a definite place in the "dipping room" of today. Last, but not least, with the demand for increased production and speed, has appeared upon the scene the so-called mechanized or automatic method of glaze application. With this new method, the problem of controlling the concentration of atmospheric glaze or mist in the vicinity of the worker, has been given a great deal of consideration.

It is not within the province of this paper to delve into the more intricate technical aspects of ceramic glaze formulation. For more detailed information on the subject, the reader is referred to Searle,[3] Koos[4] and "Ceramic Catalogs."[5] Attempt is made here to show by only one example and its practical application that the *atmospheric lead concentrations* due to *glaze mists, can be kept within reasonably safe limits.*

The principal constituents most commonly found in glazes are the oxides of the following minerals: silicon, aluminum, calcium, potassium, sodium, lead, and boron. To supply these from raw materials, a preparation of finely ground and intimately mixed silicates, boro-silicates, and in many cases flint, feldspar, clay, boric acid, borax, basic lead carbonate, litharge, red lead, or a lead silicate is used. As a typical glaze formula "Ceramic Catalogs"[5] gives:

Silica	(SiO_2)	61.00%
Alumina	(Al_2O_3)	8.24%
Lime	(CaO)	8.60%
Potash	(K_2O)	4.96%
Soda	(Na_2O)	2.83%
Lead oxide	(PbO)	11.00%
Boric oxide	(B_2O_3)	3.37%

Of recent years, the practice is becoming more general, to fuse the constituents of the glaze into a glass-like substance called "Frit," which is subse-

* A contribution of the Silicosis Division, West Virginia Workmen's Compensation Fund, Charleston, West Virginia.

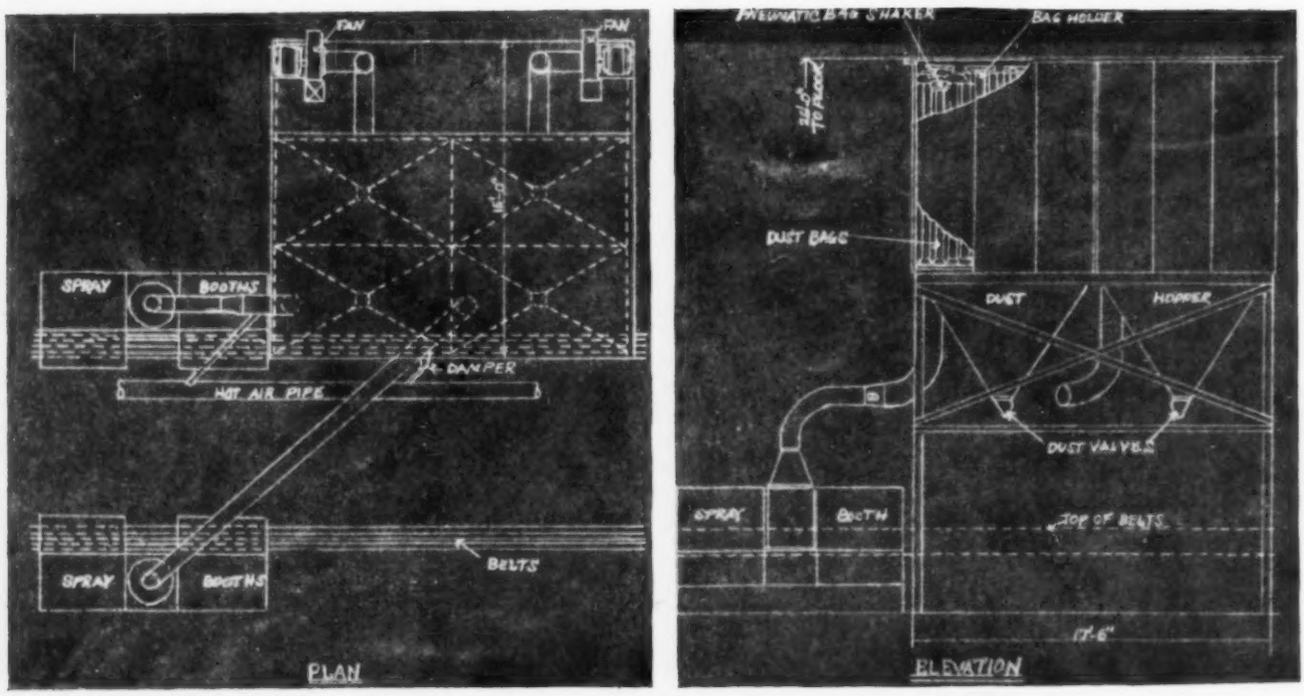

Fig. 1.
Filter Bag Dust Collectors for Spray Machine

Fig. 2.
A Typical Pottery Hand Dipping Room. (Note Lunch Box in the Foreground.)

Fig. 3.
Hand Dipping and Continuous Mangle Drying

quently ground and used as one constituent of the glaze. This results in the chemical combination of the raw materials and transforms the lead into a difficultly soluble form, presumably a bi-silicate.

In preparing the frit the ingredients are weighed, the batch mixed, put in fire clay saggers and placed in kilns or furnaces for fusing. In the more modern plants, the batch may be shoveled directly into a slowly revolving rotary frit furnace, where it is mixed and fused.

Kiln frit is allowed to cool slowly. When special rotary furnaces are used, the molten frit is usually poured into water where it cools rapidly and granulates. In any case, the fused glassy frit is ground and pulverized before it is mixed in a wet ball mill with the other glaze ingredients.

According to Koos[4] a very common vitreous china ware glaze formula is as follows:

FRIT		GLAZE	
Flint	30.8%	Frit	30.8%
Feldspar	4.7%	Feldspar	4.7%
China clay	17.0%	China clay	17.0%
Whiting	19.0%	Whiting	19.0%
Borax	28.5%	White lead	28.5%

After the raw materials, including the "Frit," are mixed with water and ground in a ball mill, the glaze which has the consistency of heavy cream, is delivered to the "dipper's tub." The "dipper" who puts the bisque ware (green clay ware which has been fired once) into the liquid glaze in a tub, gives it a peculiar twisting motion to insure an even coat of glaze on all the surfaces. The "dipped" ware is then placed on boards or drying mangle tiers over the tub. The dipper's helper removes the dipped ware to driers and sponges off the excess glaze. From "holloware," such as creams, sugars, etc., the removal of excess dry adhered glaze is accomplished by means of a wet sponge, buffing machine, or dry piece of carpet. After drying and excess glaze removal, the ware is ready for the second firing which takes place in the "glost kiln."

A more recent innovation gradually replacing hand dipping in large open tubs is the introduction of automatic mechanically exhausted spray glazing booths, illustrated in Fig. 1, redrawn from the "Proceedings of the United States Potters Association."[6] Installations of this kind are coming into general use, particularly in glazing flat ware. For this reason, a number of tests were conducted on one of these machines with the hope of being able to compare their operation with older dipping methods from a hygienic standpoint.

Atmospheric dust samples were obtained at

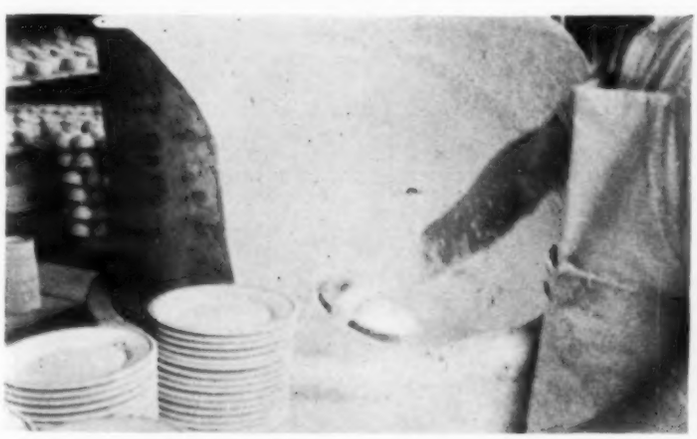

Fig. 4.
Close-Up of Hand Dipping Operation

Fig. 5.
A "Sagger" Loaded with "Dipped Bisque" ready for Glost Firing

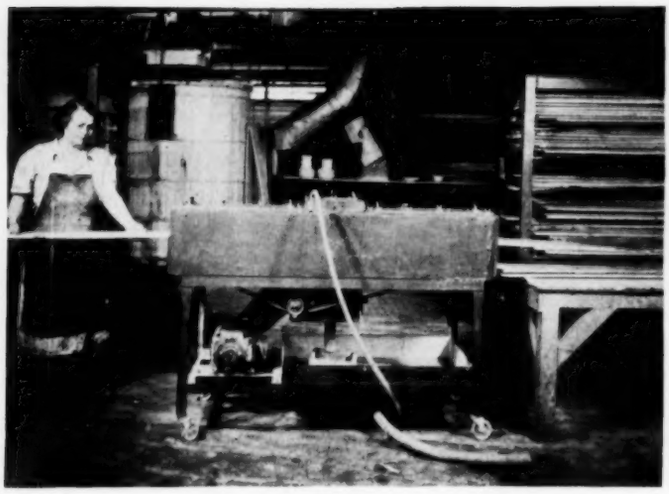

Fig. 6.
Mechanical Washing of Dipped Ware Carrying Boards, as shown here, presents an Effective "Good Housekeeping" Procedure

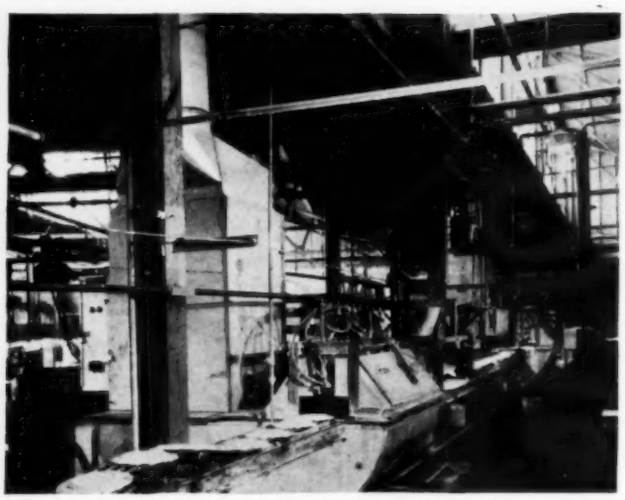

Fig. 7.
A Modern Mechanical Spray Glazing Installation

various locations in and around the spray booths by means of the Greenburg-Smith impinger and counted according to the technique described by Bloomfield and DallaValla.[7] The results of these determinations are given in Tables IV and V of this report. Ten cubic meter air samples, employing the impinger technique, were obtained and shipped to Dr. Lawrence Fairhall, of the United States Public Health Service, who analyzed these "for their lead content, utilizing chromate precipitation and final evaluation of the quantity of lead was based upon titration with 0.005N sodium thiosulphate of the equivalent amount of iodine set free by the interaction of lead chromate with potassium iodide." Occupational exposure to lead dust is presented in Table VI.

In automatic spray glazing, particularly in glazing flat ware, the finely divided fluid glaze is forced under pressure from a number of jets or guns so mounted in booths that every section of the piece is thoroughly covered by the spray. The "bisque" pieces are carried past the spray guns on a narrow endless band conveyor belt. In some of the newer installations, the ware is made to revolve as it passes under the spray. Otherwise, this turning over of the pieces, so that both faces are sprayed, is performed by an operator stationed between two booths.

TABLE I
ARRESTER DATA

	One Unit
Weight	8,500 pounds
Space occupied	1,445 cubic feet
Free cloth area	1,920 square feet
Power requirement	7½ H.P. motor
Static pressure	5.4 inches water gauge
Velocity pressure	1.2 inches water gauge
Air volume	4,200 cu. ft. per minute
Area of openings, (spray machine)	Both booths—10½ square feet
Air velocity, (spray machine)	400 feet per minute at opening

TABLE II
OPERATING DATA

Spray Machine	Total Pounds Glaze Recovered	Total Hours Operated	Glaze Recovery Lbs. per hour
Number 1	12,766	1,825	7.00
Number 2	18,701	2,686¼	6.96
Totals	31,467	4,511¼	6.98

TABLE III*
GLAZE RECOVERY COST DATA

Period	Glaze Recovered Lbs.	Glaze Recovered Tons	Equivalent 1150 Lb. Glaze Mill Charges	Approx. Value of Usual Clear Fritted Pb. Glaze
1 Week	293	0.15	0.25	$ 11.75
4 Weeks	1,172	0.59	1.02	47.00
1 Year	15,244	7.62	13.25	610.00

* Using the data given in Table II as a basis the figures in this table were calculated assuming one spray machine operates 40 hours each week.

TABLE IV.
ATMOSPHERIC DUST CONCENTRATIONS FOR VARIOUS TYPES OF POTTERY GLAZE APPLICATION

Nature and Description of operation	No. of samples	Dust Count in Millions of Particles per Cubic Foot Min.	Max.	Ave.	Control
Applying glaze—hand dipping	12	0.6	35.0	7.4	None
Applying glaze—spraying	11	2.6	107.0	28.3	None
Applying glaze—spraying*	7	1.2	7.1	3.5	Exhaust Ventilation

* Controlled.

TABLE V.
ATMOSPHERIC DUST CONCENTRATIONS FOR CONTROLLED SPRAY GLAZING OPERATION
(Showing Operating Efficiency of the Collector System)

Sampling Location	No. of Samples	Dust Count in Millions of Particles per Cubic Foot
At breathing level of girl turning plates between two spray booths	1	1.2
Sample of air from inside exhaust duct directly above spray booth	1	115.0
Sample of air from inside exhaust duct close to inlet of cloth screen collector	1	114.0
Air sample from exhaust stack clean air discharge side of cloth collector	1	1.5

TABLE VI.
OCCUPATIONAL EXPOSURE TO LEAD DUST IN THE POTTERY INDUSTRY

Occupation	Pb. Exposure in Milligrams per 10 Cubic Meters Min.	Max.	Mean	No. of Samples	Remarks
Hand dipping	0.3	4.3	1.2	4	Tile and tableware—lead glaze.
Removing hollow ware from mangle	5.4	7.5	6.8	3	Excess glaze removed from bottom by rubbing on small piece of carpet.
Spray machine operator	0.7	65.0	4.4	9	Great variation in Exposure depending on type of exhaust equipment and kind and size of ware.
Frit making Hand shoveling	144.0	191.0	167.0	2	Short Exposure—one-half to one hour twice a week. Respirators used.
Loading ball mill with glaze materials	10.3	27.2	18.7	2	Frit, whiting, clay, feldspar, white lead and flint.
Rotary frit furnace loading	7.8	15.5	12.7	3	Furnace usually operated from 24 to 72 hours continuously once or twice a month, depending on demand —intermittent exposure. Respirators worn.
Hand spraying, special shapes and glazes			1.4	1	Intermittent exposure, no control.

To carry away the excess spray mist these machines are provided with exhaust ventilation. In Tables I, II, and III will be found some specific data justifying the installation of these machines from an economic standpoint. These data are based upon an actual operation period of 14½ months. The cost of maintenance has been almost nil. On the system two glazes have been used successfully, one a colorless, the other, a light yellow in color. In order to clean the arrester, it has not been necessary to resort to other than the usual shaking of the filter bags. When it is necessary to use glazes requiring the changing of bags, it necessitates four to eight hours to make the change, depending, of course, upon the experience of the workman.

Summary and Conclusion

DIPPING ware by hand, illustrated in Figs. 1, 2, and 3, does not necessarily create a great deal of dust, as can be readily seen in Table IV. What dust is found is caused by the accumulation of dried glaze on the ware boards, the floors, the tubs, walls and clothing of the workers. In dipping, this accumulation is caused by no other reason than the careless splashing of glaze during the operation. Careless, rough handling of ware boards, especially dropping them down on end, probably

TABLE VII.
NUMBER OF CASES OF LEAD POISONING AND NUMBER OF DEATHS DUE TO LEAD POISONING AMONG BRITISH POTTERY WORKERS

Year	1936	1935	1934	1930	1920	1910	1900
Cases	18	18	26	23	25	78	210
Deaths	1	7	8	10	13	11	8

Taken from the Annual Report of the Chief Inspector of Factories and Workshops for the Year 1936, p. 44.

produces more dust in the dipping room than any other operation. This, coupled with the constant movement of the workers, the passing in and out of the glost placers and ware gatherers as they remove the ware from the stillyards, and sweeping during working hours are the chief producers of dust.

Recently, board washing machines, similar to the one illustrated in Fig. 5, have been introduced which tend to reduce this dust hazard.

Automatic spray glazing is not, by and large, the utopian solution to the control of lead exposure. Any machine is merely as efficient as its operation and maintenance. Unless the hoods and rates of

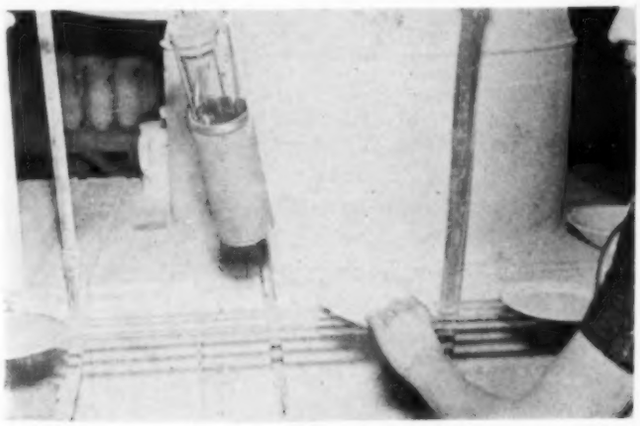

Fig. 8.
Impinger Sampling for Atmospheric Lead Dust at Breathing Level of Operator turning Sprayed Dishes

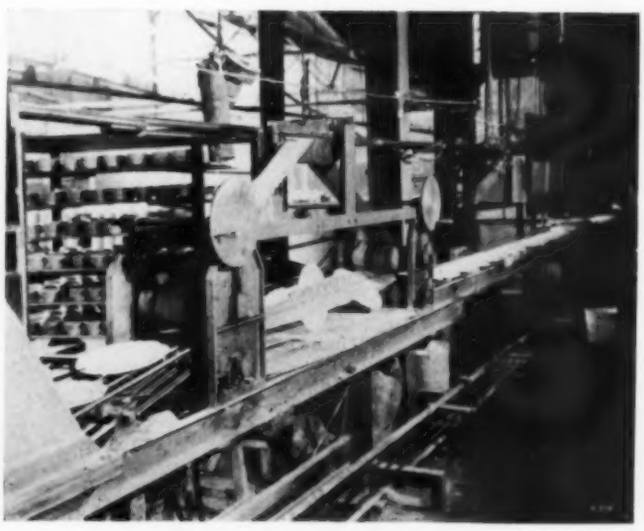

Fig. 9.
The Automatic Dish Turnover eliminates the Possibility of Operator Exposure

air flow are properly adjusted and maintained, the spray may escape into the room. In exhausting these machines, as long as the ventilation operates properly, the atmospheric dust concentration can be kept within practical, reasonable safe limits.

Only with periodic inspection and the constant maintenance of an average and uniform velocity over the face of the booths and openings, of not less than 150 ft. per minute, can efficient operation be insured.

In British potteries, Table VII, there is shown a gradual decrease from year to year in the number of cases and deaths due to lead poisoning. This marked decrease can be attributed to the splendid educational "good housekeeping efforts" on the part of the English authorities. Providing the workers with adequate sanitary and washing facilities coupled with the adoption of stringent regulations regarding the carrying in or eating of food in "dipping rooms" have aided materially in bringing this decline about.

It must not be overlooked, however, that in many plants soluble lead compounds are still being added to even fritted glazes before use. Where glazes of this kind are used for hand dipping or inadequately ventilated spraying machines, then the danger of contracting lead poisoning is as great as it was before.

The control of the hygienic exposure arising from the application of pottery glazes does not solely come within the province or responsibility of the engineer, but presents an excellent opportunity whereby the dual cooperative efforts of both the physician and the engineer can be enlisted.

In conclusion, a paragraph from Kehoe[8] best exemplifies the importance of this harmonious approach toward the elimination of an obviously important occupational exposure. "In short, it will require the combined application of the best available clinical, toxicologic, and engineering facilities to provide an adequate solution of this hygienic problem."

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Air Hygiene Foundation

—Reports Industrial Health Progress—

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INDUSTRIAL management insists upon machines of the highest efficiency. But machines at best are only machines, servants of operators in overalls. Although the machine may be 90% efficient, "what doth it profit" if the workman on the job is only 40% efficient physically? "Mechanical efficiency" has been the credo and theme of the Machine Age. This important consideration is no longer sufficient for management's needs. We live in a progressive day when industry is growing more humane and corporate management studies more and more the "human side" of America's manufacturing processes.

William S. Knudsen, President of General Motors Corporation, says: "Safeguarding the health of our employees is, in my opinion, the greatest and most important task before us at all times." Forward-looking Lewis H. Brown, President of Johns-Manville Corporation, asserts that management must hereafter be interpreted in terms of its contribution to improving the lot of the common man, to providing an increased well-being for the ordinary wage-earner and his family. Rather than "mechanical efficiency," the one clear call rising above the bedlam of our times is "human efficiency," of which health is the keystone.

An answer to this call was given in 1935 through the formation of Air Hygiene Foundation by a group of industrialists in cooperation with scientists and industrial hygienists. The Foundation was established with headquarters at Mellon Institute, Pittsburgh, shortly before the silicosis uproar at Gauley Bridge, W. Va. The sole purpose of this non-profit organization is the further improvement of employee health in industry. Research directed at developing ways and means for the control or prevention of occupational diseases is in progress, under grants from Air Hygiene Foundation, at The Saranac Laboratory, University of Pennsylvania, Harvard University, and Mellon Institute.

DR. L. U. GARDNER, Director of The Saranac Laboratory and a member of the Foundation's Medical Committee, is investigating "mixed" dusts and "protector" dusts in an effort to combat pneumoconiosis. In reporting his findings at the annual meeting of the Foundation on November 17, 1938, Dr. Gardner said:

"Experimental data supports the thesis (pro-

posed a year ago) that various minerals associated with silica tend to inhibit its action upon the body. Such inhibitory action may result both from factors operating outside and from others inside the body. Flocculation of a mixed dust in atmospheric suspension and the falling from the air of such aggregates of particles, including silica, reduces the amount of silica available at the breathing zone and probably is responsible for exclusion of much dust of all kinds by the upper respiratory protective mechanisms. More or less transitory chemical or physical combinations with various other minerals may retard the usual effect of silica particles that have already entered the body. Studies now in progress suggest that the internal effects are due to the presence of a coating of other minerals upon the quartz which reduce the amount of silica surface exposed to body fluids.

"It is extremely difficult to determine the absolute number of inhalable silica particles present in a mixed dust at the breathing zone. Exposure of animals and men for several years to concentrations of mixed dusts which *by calculation* contained dangerous quantities of free silica have produced only sporadic silicotic lesions of modified type. Control groups of animals exposed to pure quartz in the concentration theoretically present in the mixtures have uniformly developed silicotic reactions in from one-third to one-third to one-half the time.

"The effect of other factors, apparently operating inside the body, was developed in this investigation. There were injected in animals standard doses of standard sized particles of hematite, anthracite, crude fluorite, granite, and ferruginous chert, each contaminated with free silica, and the effects noted. Also, various chemical solutions were added to suspensions of silica particles in attempt to neutralize its action in different ways.

"The results of all the injection tests, in which all the particles of silica and other minerals are deliberately brought into direct contact with the tissues furnishes strong evidence of inhititor action. They indicate that while many substances may act as inhibitors not all of them are equally effective. They also suggest that various minerals may inhibit tissue reaction to silica provided that this substance is a minor constituent of the mixture. When the proportion of silica reached 50% or more of the mixture prolonged contact with the tissues may ultimately cause fibrosis. Observation over longer periods than those reported will be required to evaluate the influence of the time factor.

"The early observations on the protective effects of metallic aluminum and the hydroxides of aluminum and iron indicate that each of these substances may be more potent than the other minerals investigated. Observation has shown that with the addition of variable quantities of these different substances to a fixed dose of quartz there are varying degrees of inhibition. At the present time it is not clear whether these differences are due to inherent physical properties of the protector substances or to the formation of new chemical compounds.

"The data suggest that analysis of the rock being worked does not necessarily constitute a measure of the silica hazard in a particular industry. When more evidence has been analyzed it may be found practical to use the proportion of silica in the atmosphere as the basis of state codes. . . .

"The principles involved in these studies probably explain the variations in the rate of development of silicosis in different industries. Ultimately they may make it possible to neutralize the effects of silica upon the body. At the present time their influence is not sufficiently understood to be used in this manner. In the writer's opinion the major objective in the campaign against silicosis is still the elimination of silica dust from the working atmosphere."

DR. S. REID WARREN, JR., reported to the Foundation on the roentgenopraghic studies which he and his associates are making at the Moore School X-Ray Laboratory, University of Pennsylvania. They are endeavoring to improve and standardize x-ray techniques for industrial purposes, as in the case of medical examinations of large numbers of industrial workmen. Dr. Warren describes the work and the results as follows:

"The purpose of this investigation was to make chest roentgenograms (x-rays) on paper and on film of patients having a variety of types of lesions of the chest and to submit these test roentgenograms to experienced roentgenologists in order that they might compare the roentgenograms and determine the relative merits of paper and of film for industrial surveys.

"The first part of the research comprised a study of the qualities of films which might be produced by varying controlled technical factors. From the data so obtained a definite standardized procedure was chosen. Approximately 100 patients were then roentgenographed according to this standardized procedure. These patients varied in weight from 85 pounds to 210 pounds. A few of the chests were normal, some had minimal tuberculosis, some had advanced tuberculosis, others had silicosis, and there were examples of other types of chest pathology as well. Of most of these patients one roentgenogram was made on paper and one on film. From this large group approximately 60 roentgenograms (30 film, 30 paper) were selected. Of other patients six or eight roentgenograms were made on paper and on film using techniques which differed in such a manner that each series contained films varying in density and in contrast, two of the important characteristics of reading.

"Thirty-five roentgenologists in the east and middle west were chosen as representatives of those men in the field who are experienced both in the reading of chest roetgenograms and in industrial problems. Among these men were those who have been both favorable and opposed to the use of paper. The films were then taken to the laboratory of each of the 35 roentgenologists. These specialists were asked to look at the film and paper for each patient and to answer the question:

'From the given examples of film and paper roentgenograms presented would you state that paper roentgenograms are satisfactory for industrial survey work? Yes..... No.....' and then to qualify his remarks by describing why he had answered this question 'yes' or 'no.' He was asked finally to tell whether it was easier to examine film or paper roentgenograms and to explain his reasons.

"These replies were analyzed in order to prepare the groundwork for a standardization of roentgenographic procedure in industry. It is apparent from the data so obtained that paper roentgenograms may be used for survey work if the technique is at least equal to that used in the tests and if means are available for following up suspicious cases by the use of stereoscopic roentgenograms on x-ray film. This conclusion is qualified by the fact noted by most of the men who examined the films that x-ray film has a wider range of density than x-ray paper. In conclusion, the results of this survey are interpreted in terms of the practical procedure in industrial surveys."

PROFESSOR PHILIP DRINKER, of the Harvard School of Public Health, and Chairman of the Foundation's Preventive Engineering Committee, says in part in his annual report:

"Two graduate fellowships have been established by Air Hygiene Foundation at Harvard University to train men in industrial hygiene. This will help build up a skilled personnel to meet increasing demands from industry and government for industrial hygienists. One candidate will study fundamentals of hood design for control of gases, vapors, etc. The other fellowship will study the identification and distribution of dusts in tissue.

"New solvents which were laboratory curiosities a few years ago are now sold in carboy and tank lots. This development brings new problems to the industrial hygienist. During 1938 the Preventive Engineering Committee issued seven bulletins covering practical measures for combating industrial health problems. The bulletins covered Determination of Benzol Vapor, Use and Care of Respirators, Determination of Chlorinated Hydrocarbon Vapor, Design of Exhaust Hoods, Design of Duct Work for Exhaust Systems, Determination of Lead, and Identification of Industrial Dusts. The question of 'What is the best apparatus and method for dust determination?' is still about where it was a year ago. . . . The Bureau of Mines has described a midget impinger which is run at a few liters of air per minute, instead of one cubic foot (28.3) liters. This equipment, light and hand operable, may gradually replace the large impinger. . . . The various grab samplers are useful, particularly for routine control. . . . There is great need for a critical survey of design and operation of existing exhaust systems in industry."

THEODORE C. WATERS, Chairman of the Maryland Occupational Diseases Commission, and a member of the Foundation's Legal Committee, advised members of the organization that: "Twenty-one states have laws compensating disabilities arising from occupational diseases, and as we look forward to the 40 odd legislative sessions in 1939, there will undoubtedly be additional states enacting laws providing a form of compensation.

"Since disabilities caused by those diseases called 'occupational' are far less numerous than those caused by the other common ills of life, it is a matter of concern to industrialists today that occupational disease laws should not be administered as general health insurance laws, to provide compensation for time lost by employees due to common ills. . . . It is regrettable that occupational disease legislation has not been more uniform, although future amendments may tend toward uniformity. . . . When we analyze the provisions of the law of one state providing compensation for one specific disease and compare these provisions with the law of an adjoining state, we realize that this legislation is still in its infancy and subject to drastic revision. It is too early to predict whether or not the administration of the laws presently enacted will be successful, but if they fail, they should fail because of their inherent defects and inequalities, and not because of the attempt by employers to avoid. . . . costs for compensating injuries resulting from operations to which their employees have been subjected."

In discussing the work at Mellon Institute, DR. MELLER, Managing Director of the Foundation, said that a number of plant surveys have been made for member companies during the past year to determine concentrations of toxic fumes, gases and dusts. Approximately 1000 abstracts have been issued during the year, summarizing pertinent articles in the literature on industrial health subjects. From the headquarters at the Institute, the Foundation also serves as a central clearing house for information on industrial hygiene, performing in this respect an increasingly important function because of the widespread and diversified work now being conducted by scores of agencies in this field.

Dr. Meller explains that the Foundation represents a collective effort upon the part of some 250 industrial concerns, aided by scientists, physicians and engineers, toward further improving and safeguarding the health of industry's workmen.

Freedom from Noise

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WHETHER awake or asleep the ear is exposed to all surrounding noises. In the slow process of evolution the eyes have acquired lids with which we can obtain freedom from the glare of light and the distracting influences of changing scenes. Apparently, nature has not as yet sufficiently anticipated the ill effects of mechanical noises to evolve protective "ear-lids." The jackass and a few other animals can at least drop their ears, and thus gain a little relief from

noises; but man for a long time to come must rely upon his own contrivances to relieve him from the injurious effects of noise.

The damage mankind suffers from noise has not as yet been adequately investigated, neither by scientists nor public health officials. It is well known that prolonged exposure to the ordinary noises of many occupations — riveting, forging, weaving, and hundreds of other types of factory employment—results in premature loss of hearing; and that even short exposure to explosive sounds often results in serious injury to the ears. But accurate data are lacking in respect to the actual damage to the ears caused by sounds of different loudness, pitch and quality, and of different lengths of exposure. It is well established that the extent of the injury increases with increase of loudness (at loudness level of about 130 phons* the sound becomes painful) and of duration of exposure; and it is claimed by most investigators that high-pitched sounds produce greater damage than do low-pitched ones. This last claim is reasonably well supported by animal experimentation, although more data are yet desired. The writer's experience with four observers has revealed that exposure to high-pitched sounds is much more likely to induce tinnitus (subjective head noises) than is a similar exposure to equally loud sounds of low pitch.

It also is well known that the length and soundness of sleep are disturbed even by ordinary noises, and many persons accustomed to quiet surroundings may suffer serious insomnia owing to the noise in a Pullman car or in a metropolitan hotel. Although there are sufficient data to indict noise as a super-thief of sleep and rest, most people are not aware of the amount of sleep they sacrifice to this "racket."

One finds in searching the literature on noise and its effcts on humans that there are many data to show quantitatively how noise reduces the efficiency of office and factory workers, how it interferes with the accuracy of operators and telegraph exchanges, and how it disturbs the hearing of speech in the office or auditorium. It is relatively easy to procure such data, and undoubtedly the economic value of the findings has encouraged research in this direction.

BUT noise probably exacts its greatest toll in its effects upon the general nervous system, especially upon mental workers, neurotics and many others who are otherwise ill. Hospitals are notoriously noisy, and one hears no end of complaints respecting the noise in hospitals. Sanitation has called for painted hard plaster walls and ceilings, concrete or at best linoleum-covered floors, and simple metal furniture—surfaces which reflect and reverberate sounds such that they accumulate to excessive loudness and then propagate to all parts of the building. Noise often delays convalescence and not infrequently is responsible for relapses or even complete nervous breakdowns. The writer was himself dangerously threatened by such a breakdown in a noisy hospital in the Northwest, while suffering with a bleeding ulcer. The "swishing" noise of coal sliding down a metal chute, just outside my window, punctuated by the impact noises made by another neighbor splitting firewood on a wooden platform, was nearly sufficient to "tip the delicately balanced scales." It was indeed this experience which led to my present interest in noise abatement and ear defenders. I got some relief from plugs of cotton or cotton and wax inserted in the ear canals, but they did not shut out enough noise. I conceived the acoustical design of a simple type of ear stopper which I knew could be made by a competent rubber technician. Some 15 months later I was invited to discuss a paper on "The Ill Effects of Noise on Humans" by DR. CAREY P. MCCORD, read before the San Francisco meeting of the American Medical Association, in June, 1938. In preparing the discussion of this paper I made a number of measurements of the amount of sound-insulation provided by different types of ear stoppers or defenders, and, with the help of the departmental instrument maker, MR. HENRY JUNG, made an experimental model of the stopper I had devised while a hospital patient. The measurements, made by means of an audiometer first with nothing in the ear and then with the stopper in the ear, indicated that cotton stuffed in the ears provided an insulation (at a frequency of 512 cycles, which is an octave above middle C) of only 7 decibels (db); cotton rolled tightly into a tapered plug gave 12 db.; cotton and vaseline plugs gave 25 db.; other patented plugs gave 25 to 30 db.; and the newly designed one (which is made on the principle of a double partition separated by a flexible coupling) gave 48 db. Subsequent modifications of this new ear defender have improved the insulation to as high a value as 58 db. (at 512 cycles). A set of measurements, at octave frequencies, for the best design made and tested to date is given in the following table:

Frequency of Test Tone, Cycles per Second	Insulation in db. Measured with Sonotone Audiometer
128	45
256	50
512	58
1024	50
2048	40
4096	48

The amount of insulation indicated in this table is comparable with that supplied by the temporal bone and other anatomical structures which surround and imbed the internal ear or cochlea, so that the device gives nearly as much insulation as would result if the middle and external ear were replaced by solid bone. The device here tested consisted of a tapered pure gum rubber tube about one-half inch long, closed at the inner end with a soft rubber plug or knob, and closed at the outer end with a metal plug. The two plugs are thus separated by an air space and the flexible walls

* The "phon" is now the standard unit for the measurement of loudness level. In recent years, the "decibel" has been used in this country for both the unit of loudness level. A barely audible sound has a loudness level of 0 phons; ordinary conversation or street noise, 60 to 70 phons; a noisy factory, 90 to 100 phons.

of the tapered rubber tube. By varying the dimensions and mass of these plugs, the dimensions of the air space, and the flexibility of the rubber, it is possible to alter the insulation characteristics of the device in such a manner as to make it most suitable for the different uses encountered in practice.

The writer has used ear defenders of the type here described every night for the past three months, and has experienced no irritation of any kind. On the other hand, they have contributed more to prolonged and undisturbed rest and sleep —in Pullman cars, on an ocean liner, in an airplane, in hotels, and even in a quiet residence, where the only source of noise was the singing of birds during the early morning hours—than any sedatives or sleeping recipes he has ever tried.

To be able to shut out nearly all undesired noise at will should prove to be of real benefit in conserving the hearing of those who work in noisy occupations; in promoting the recovery and welfare of the sick and neurotic; and in assuring sleep to all those who are disturbed by noise. The proper use of ear defenders will provide these benefits.

Hand Injuries

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THE old Roman maxim, *minima non curat praetor* ("the praetor need not trouble about trifles") unfortunately has gained a foothold in medical ideology, especially in traumatic medicine. And still it is not always the result of a major injury that should necessarily absorb our greatest attention. Frequently it is the result of an apparently minor damage that supplies us with a wealth of interesting studies.

How often through oversight of these "trifles" is the proper therapy neglected; how often the correct judgment of the care, the correct estimate of the claims of the injured party made impossible!

A rule which is followed much too rarely is the necessity of taking x-ray pictures immediately after the injury.

The omission in the cases which even remotely suggest the possibility of bone injury is an error which may justly spell serious liability for the attending physician.

We know that frequently severe pathologic changes in the bony structures can be proved by x-ray, although the patient has been wholly unaware of their symptomless development. Frequently it is possible immediately after an injury to reveal unequivocal evidence of pre-existing conditions which had not heretofore become manifest. Without difficulty one can distinguish pathologic processes due to the accident from those due to any pre-existing chronic change. Pictures taken for comparison finally permit one to decide whether the trauma has aggravated the condition or whether a *restitutio ad integrum* has occurred.

A case where absence of authentic x-rays immediately after the accident has led to a faulty diagnosis and to the avoidance of urgent therapeutic measures recently came to our attention.

A dock worker sustained an accident approximately one year ago. Apparently a bale of 300 pounds fell on his right hand. According to the opinion of the patient this accident caused a contracture of the fourth finger of his right hand.

Examination revealed definite signs of Dupuytren's contracture, albeit in the earliest stage. This condition naturally had no relationship to the accident. The injured who cannot judge the consequences of his mishap discovers the limitation in the use of his fingers which before had scarcely been noticed. The physician is misled by the complaints of the patient, and notices merely the Dupuytren's contracture but fails to make a careful examination of the wrist or to advise an x-ray examination.

The result is that the claims of the plaintiff are rejected with the explanation that the Dupuytren's contractures bear no relation to the alleged accident. Careful study of the x-ray pictures taken one year after the accident shows a definite cyst of the os naviculare of the right wrist, the result of a fracture (Fig. 1). It must be admitted that fractures of this small metacarpal bone are often overlooked. Frequently, even when pictures are taken, diagnosis of strain of the wrist is made and the correct opinion rendered only later when continued disability compel another x-ray study which usually shows the fragments in a poor apposition. The space between the fracture line is often so fine at the early stage that it can only be diagnosed by use of a hand lens. Only later do the fragments separate and thereby make an x-ray diagnosis definite.

In a certain percentage of cases, especially among those not diagnosed and therefore not properly treated, when fractures of the os naviculare occur, cysts will develop. These have given rise to many theories. Preiser (Hamburg) was first to call attention to these cysts. He associated them with metabolic disturbances resulting from separation of the blood vessels. Hirsch (Vienna) has assumed that the trauma causes a destruction or necrosis of the spongiosa. Other explanations assume that there is a post-traumatic primary ostitis with only a secondary spontanous fraction.

In accordance with Schinz, who in 1911 reported exhaustively on the cavitation of the os naviculare, we are of the opinion that the cyst in this bone following trauma represents nothing else than a so-called second stage of a fracture healed by pseudo-arthrosis.

Similarly we assume in this case that the cyst formation in the right os naviculare resulted from

the fracture which the first physician had overlooked. Complete rest of the wrist for eight or 10 weeks would most probably have prevented the pseudo-arthrosis and avoided disability, at least to the degree that was present.

Another case, which is not too common, resulted in a condition which could have been avoided if the diagnosis had been made correctly by x-ray in the first place.

Here we are dealing with a man who was hit by a chip of wood that struck against his right index finger. Immediately after the accident marked swelling occurred, especially in the region of the metacarpo-phalangeal joints. He was referred to a hospital. Gradually the patient noticed that his

Fig. 1.

Fig. 2.

Fig. 3.

right index finger "forcefully" assumed a marked tendency towards flexion. Six months after the accident the man was examined by us. This revealed that the index finger was markedly contracted. The skin showed no abnormalities, neither the skin or the tendons were taut or stretched. Conspicuous was a marked degree of sweat formation of the finger in contrast with the other fingers of the hand. The thumb and the other fingers were practically normal. The palmar surface of the hand showed no evidence of contractions or atrophies such as are characteristic of Dupuytren's contractures. The movements in the wrist were perfectly normal, contrary to what one would expect in Dupuytren's contracture — it was possible to stretch the right index finger without the least effort. The finger would remain in this stretched position for about 30 seconds and then slowly return to the state of extreme flexion (Figs. 2 and 3). It was noticed that the index finger was not only in flexion but also in slight ulnar abduction. The patient himself was not able to overcome the contracture. The x-ray picture showed a subluxation of the first phalanx of the index finger and a mild fracture in the hand of the second metacarpus.

These cases have been described by Oppenheim as pseudo-contractures following a traumatic neurosis which is associated with the minor injury to the metacarpo-phalangeal joint. Here again we are dealing with a case which because of neglected x-ray diagnosis was not given proper attention. Complete rest in extension for two or three weeks would have sufficed to heal the joint fracture and in that way to prevent the pseudo-contractures.

AND now in conclusion another equally unusual consequence of an injury. Quite as often as we find detachments of the extensor tendons of the fingers, just as rarely do we find a detachment of the flexor tendon. In this case we are dealing with a detachment of the tendon ends of the flexor digitorum sublimis.

The patient described the following accident: "I caught the left small finger in a safety pin which was attached to a steel arm on which the bundles hung. As the finger was caught a bundle fell off the table and jerked my finger to the side."

The left small finger showed marked tenderness between middle and proximal joints and at the metacarpo-phalangeal joint.

A similar case has been described by Sick: A man who wanted to widen a button hole, by putting his ring finger in and then receiving a blow on the flexor sublimus which was turned upon itself.

Hegeler described a case in which a man caught his ring finger in a stretched position in the dress of a passing fellow performer (marked hypertension). On the volar side of the first phalanx there was a bean-sized swelling that moved up and down, the rolled-up end of the flexor profundus.

Another case is described by Lessing. The patient falling down the stairs caught himself upon his outstretched hand. In the region of the metacarpal-phalangeal joint of the ring finger a marked bean-sized swelling appeared. Active flexion of the second interphalangeal joint imposible, while passive flexion is undiminished. The operation shows the transversally severed flexor tendon.

In all cases we are dealing with the detachment of a flexor tendon in the moment of marked passive hypertension. According to the rarety of ruptures of the flexor tendons these injuries are often not properly diagnosed.

The failure to make a proper diagnosis leads to the omission of immediate operative correction and consequently to the irreparable damages which may restrict the usefulness of the hand.

The purpose of this paper is to call to the attention of the general practitioner that the "minor injuries" of the hand deserve more attention. The failure properly to care for supposedly slight trauma often results in most unpleasant consequences. Especially in the evaluation of injuries to the hand, one must again strongly warn against the erroneous maxim *Minima non curat praetor.*

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Trauma to Blood Vessels

—*And Their Sequelae*—

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MOST fields of surgery permit of a more or less elastic period of temporizing therapy with watchful expectancy.* There is often also a wide choice of therapeutic maneuvers which may vary little in their effectiveness. In vessel injuries, however, the dramatic onset and rapid development of the clinical climax which places the patients life or limb in jeopardy demand immediate and decisive treatment. The consequences of ill chosen management are so pressing and appalling and the rewards of correct treatment so gratifying that from earliest history surgeons were forced to apply themselves assiduously to the problem. At an early date many problems of blood vessel surgery were decisively solved to the extent that certain fundamental principles were laid down which have been altered little in centuries of surgical development.

The ligation of blood vessels was described in the ancient Hindu Vedas in connection with constriction of the umbilical cord of newborn infants. The complete success of this maneuver and its consequent unmodified persistence to this day depends on the fact that the ligature was applied virtually to an external part of the body and was left completely open to slough off in the face of whatever infection developed. The ligation of large vessels in amputation stumps was early successful for the same reason. Paré was able to substitute it for the brutal method of hemostasis of amputation stumps by boiling oil then in vogue. In these early times when ligation was applied to deep wounds, however, these favorable circumstances were not present. The suture material buried with infection in the wound favored sloughing of the perivascular and vascular tissues and liquefaction of the clot. Repeated disastrous secondary hemorrhages prevented the widespread use of the ligature in this type of wound. It was not until the advent of aseptic surgery that the buried ligature became sufficiently safe to encourage its general adoption.

In ligating major blood vessels in deep wounds, a comprehensive knowledge of anatomy became essential. The increasing knowledge of vascular anatomy culminating in Harvey's exposition of the direction of flow within the vessels met this requirement and permitted accurate application of the ligature. As important as ligation was for life saving hemostasis it sometimes carried in itself a very great disadvantage. The frequent occurrence of gangrene in the region to which the injured vessel carried blood showed clearly the necessity of some method of restoring the continuity of the vessels. The first successful attempt to accomplish this was made in 1759, when Hallowel closed a lateral rent in the brachial artery by an ingenious compromise between ligature and suture. He pierced both edges of the vessel rent with a pin and laced a ligature beneath it. The experiments of Assmann in 1772 discouraged for a time the use of the suture by demonstrating the frequent thrombosis which attended it. Later with improvements and refinements in the technic of vascular suture by such men as Jassinowsky, Dörfler, Murphy, Silberberg, Jianu, Brican, Jaboulay, Matas and Carrel, this difficulty was largely overcome. The difficulty of accurately repairing an injured vessel wall in the face of a constant flow of blood forced the development of various methods of temporary control. Gluck was the first to demonstrate that blood flow could provisionally be controlled without inducing permanent occlusion of the lumen.

To this day an accurate knowledge of vascular anatomy, the correct application of the ligature, the suture, and provisional vessel control are the major principles upon which all modern vessel surgery is based. Secondary factors of varying importance may require further consideration in analyzing the problems which acute vessel injuries present. These include the role of wound sepsis, acute hemorrhage, age and general condition of the patient and the presence of additional complicating injuries. The primary factors are still of first importance.

It is an uncomplimentary truth that an intimate knowledge of most of these factors was quite universally enjoyed by the well trained surgeons of several generations ago. With the increasing scope of medical and surgical education it has become increasingly difficult to retain mastery of the fundamental principles which sufficed the older surgeons in their more circumscribed fields of activity. A review of these principles in the light of modern practice will emphasize even at the cost of repetition those practices which should be mastered by every well trained general surgeon of today.

In the treatment of recent vascular injuries, the considerations which demand attention are: (1) The presence and severity of external hemorrhage: (2) The presence of evident contamination or infection; (3) The condition of the circulation distal to the point of injury; (4) The severity of complicating injuries; (5) The postoperative care.

1. Hemorrhage

PROFUSE external hemorrhage supersedes all other considerations in importance and in the necessity of immediate action. The alarming circumstances of profuse blood flow have frequently

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led, however, to ill-advised manipulations with needless destruction of vessel tissue. Everyone is familiar with the elective sites for application of direct pressure or of tourniquet compression. Esmarch long ago emphasized certain principles in the application of tourniquets which should be kept in mind:

1. Elevation of the extremity before application assists in hemostasis.
2. The tourniquet should never be applied to the lower leg or to the forearm because the blood vessels escape compression between the two bones of the part.
3. The tourniquet should be applied to the adductor side first to secure immediate arterial occlusion without marked venous congestion.
4. Caution must be exercised to prevent sudden flexion or extension of the limb after the vice-like constricting tourniquet has been applied.
5. The tourniquet should not be applied in successive overlying loops because each loop then exaggerates the constriction of the preceding one. An interval should be allowed between each loop.
6. The tourniquet should not be left on any longer than is absolutely necessary.

The most common error in tourniquet application is applying it with force less than that of the systolic blood pressure. This permits serious congestion distally and aggravates the bleeding. A frequent basis for this error is that the tourniquet is applied while the patient is in shock and when only slight constriction is necessary to stop the bleeding. In the first reaction after shock the systolic pressure rises above that of the constricting tourniquet which then becomes a virtual detriment in the control of hemorrhage. Some reservation must be made in both the force and duration of application of the tourniquet in individuals with diseased arteries. Inordinate pressure may rupture the intima of sclerotic arteries, and result in local thrombosis. Prolonged constriction of these vessels may also lead to distal thrombosis with similar disastrous consequences to the leg.

In locations which do not admit of tourniquet application such as the neck, trunk and the immediate roots of limbs, a series of ingenuous methods of arterial control have been developed. These are so bizarre in character that they do not readily permit of classification. In each location, surgeons have taken full advantage of local anatomic conditions to devise easier and more reliable methods of controlling hemorrhage. These include such maneuvers as the intercostal plug in intercostal hemorrhage, pneumonothorax in pulmonary vessel wounds, the rectal tampon and the spring and elastic compressors. Full advantage is often taken of direct compression methods, especially those which utilize adjacent bony prominences against which the compression can be made and of the assistance which simple elevation renders.

In the absence of profuse external hemorrhage, a concealed hemorrhage may be of sufficient severity to endanger life. The gravity of hemothorax or hemoperitoneum is apparent, but the dangers attending interstitial hemorrhages are not sufficiently appreciated. Blalock has recently called attention to the large quantities of blood plasma which may be lost from the physiologic circuit into the loose tissues of the groin or axilla, without leaving the body. In a previous article we have called attention to the serious isolation of formed elements from the blood stream in interstitial hemorrhages accompanying injuries to large vessels. The fluid elements are quickly absorbed leaving more space for packing and concentration of formed elements. An interstitial hematoma of one liter may actually represent a blood loss of two liters. These situations demand intervention with almost as much urgency as does profuse external hemorrhage. These local interstitial losses of blood can usually be stopped by direct compression, or by tourniquet application if the site is suitable, in exactly the same manner as profuse external hemorrhage.

The ideal conditions for the subsequent management of these desperate cases should almost always include pre-operative blood transfusion. This condition is, however, not frequently fulfilled. Compatible donors are often not immediately available. In cases where a tourniquet has been applied to an extremity, the delay attending the selection of a donor and the administration of blood, coupled with the time necessarily consumed in the definitive operation may exceed the period the limb can safely tolerate a deprivation of circulating blood. In locations where hemostasis is effected by direct compression rather than by tourniquet application more time may be available for donor selection and blood transfusion. In every instance, glucose solution, intravenous salt solution, or gum acaciae can be administered before or during the operation. In addition, in the desperate cases, full advantage should be taken of the effect of autotransfusion by bandaging the limbs.

In many cases the external hemorrhage is quickly and easily controlled or the hemorrhage if concealed is checked in extent before there is any primary dangerous loss of blood. These cases must not be dropped from careful observation, because in some, the initiation of activity precipitates recurrent hemorrhage or extension of the hematoma, which eventually though insidiously is as dangerous to life and limb as was the initial acute profuse hemorrhage. The extrusion of consecutive clots from an open wound or the intermittent progressive extension (not migration) of a hematoma demand intervention before serious secondary accidents develop. On the other hand, in the absence of these signs, under the resumption of moderate activity, watchful waiting is permissible. If external hemorrhage shows no tendency to recur or if the hematoma subsides, the problem may be considered solved for the time being but the possibility of the development of a late traumatic simple or arteriovenous aneurysm or nerve inclusion in the resorptive scar must not be overlooked.

2. The Factor of Infection

THE management of the acute vascular injury is also dependent on the presence or absence of evident contamination or infection in the wound. The extent and virulence of concomitant infection is a varying factor which often cannot be predicted accurately at the time of the initial injury (See McNealy, Section on Surgery of Aneurysms, Lewis' System of Surgery). In cases where the penetrating or incised wound is sharply cut and circumscribed, with no evident gross contamination, and especially where the wound edges have been freely washed by the outflow of blood, the amount of subsequent infection is usually small. However, even such wounds should be but loosely sutured, if at all. A common error is the accurate suture of the overlying tissues in ignorance of the vessel wound and the sealing in of foreign material, blood coagulum and whatever bacteria were included, to play secondary havoc with the vessel. The procedure to be followed in these cases depends on the size and importance of the vessel involved. An estimate of the importance of the vessel injured may be obtained from the amount and force of the hemorrhage sustained before the temporary artificial control was applied. The points of entrance and exit and the probable path of the missle are also of some value, but can, on the other hand, be very misleading because of the erratic course which missiles often take between muscle and fascial planes.

If it be decided that the vessel involved is small and unimportant, intervention may not be necessary, but the wound is kept open and under close watch until all danger of spreading infection has passed. If it be felt, however, that an important vessel is involved, then even though the wound is small and apparently clean there should be no temporizing with packing or continued direct compression. These measures only prevent the free drainage from the wound of foreign and occultly infected material. They expose the patient to the possibility of repeated secondary hemorrhages by exaggerating and complementing what may originally have been only a minimal contamination. In such cases, the vessel should first be controlled by provisional occlusion and then exposed freely, avoiding as far as possible the original accidental wound. The final restorative or obliterative management of the vessel wound is then accomplished according to the indications discussed below.

In doubtful cases, where the size of the vessel is not known, but where there are minimal soft tissue injuries and no gross contamination or infection, the wound is left unsutured and carefully watched. At the first evidence of recurrent bleeding, clot extrusion or developing infection, surgical intervention is demanded. If the indication for intervention is recurrent external bleeding or extending hematoma or progressive clot extension, the surgical approach may be made as in the preceding type of case. If the indication is infection only, the situation is met by simple adequate drainage of the infected region.

The most harrowing situations in blood vessel surgery, however, are where the infection is accompanied by secondary hemorrhage. In these cases the problem of stopping further secondary hemorrhage is even more important than that of preventing gangrene. Too often temporizing measures are hazarded to preserve adequate circulation in the limb at the cost of the patient's life by hemorrhage from failure to secure decisive control of the vessel. The majority of mistakes in handling such problems occur when an attempt is made to ligate the bleeding vessel by approach through the original infected wound. In most cases after provisional control of the feeding vessel is made, it is probably safer to ligate the vessel in a clean field at some distance proximal to the infected area. However, where conditions prevent proximal ligation, as for example, at the immediate root of an extremity or the base of the neck, or where collateral circulation is so rich as to allow continued hemorrhage as in the hand, foot, head or neck, a direct attack on the bleeding point becomes imperative. In these situations, an incision is made over the bleeding vessel avoiding as far as possible the original wound, and with a minimum of dissection the vessel is exposed and controlled. Its division is completed if necessary and the ends are closed by non-absorbable suture. The incision is left freely open. The infected area is then freely incised to provide adequate drainage and great care is exercised to expose every ramification of the infectious spread.

In cases which come in with extensive soft part injuries or with evident gross contamination, a moderate or severe infection can usually be anticipated. These cases should be handled in the manner just described, just as if they were already infected and recurrently bleeding.

The importance under these conditions of completing the division of the vessel, as well as the importance of minimizing the dissection was emphasized by Abernethy in his monograph on "Surgical Observations" published in 1811. Our paper cannot add to the accuracy of his basic observations. We can only call attention to them.

It seems strange that at this time, too, we must recall the efficiency of non-absorbable suture material which the older surgeons emphasized decades ago. Aseptic surgery encouraged the promiscuous use of absorbable suture material. It has become one of the fundamental modern medical school teachings that in the presence of infection only absorbable suture material should be used. While in general this is true, in vascular surgery the presence of infection is the one condition which demands the use of non-absorbable suture material upon which greater reliance can be placed. In the presence of infection, the occlusive sealing of vessel walls is delayed. Occlusive thrombi are readily liquefied and there is more urgent necessity for prolonged artificial occlusion by the ligature. Catgut with its uncertain absorbability cannot be relied on in these situations. Silk or linen must be used. This suggestion is not antagonistic to the doctrine that infectious fields do not tolerate

non-absorbable suture material. This teaching applies only to situations in which the non-absorbable material is buried within the wound. The condition which answers the objection to the use of silk or linen as ligature or suture material in infected vessel wounds, is that these wounds are left widely open, just as Paré's amputation wounds were left widely open. Even the size of the non-absorbable material to be used was well defined by the older surgeons. For small vessels fine silk ligatures will serve. For larger vessels it is better policy to use thick ligature material because this insures broad apposition with less devitalizing compression. We quote from Abernethy: "When an artery is tied with a thick ligature, the compression made by it is not so great as to produce a speedy mortification and separation of the end of the vessel so that the ligature remains in general a fortnight before it is detached, and therefore, time is allowed for the consolidation of the sides of the vessel prior to its separation." Simple ligature is often adequate. However, the advantage of ligature by transfixion was recognized by such an early worker in this field as Henry Cline, a pupil of John Hunter. At Cline's suggestion, Sir Astley Cooper first employed this procedure in 1802 *(Medical and Physical Journal,* Volume 8, No. 1).

An additional improvement in the technic of application of the ligature has been recently emphasized by Mont W. Reid. This consists of diminution of the intra-luminal pressure against which the ligature has otherwise to be tightened, by temporary proximal compression of the vessel while the ligature is being drawn into place. This reduces the excessive force and crushing which is otherwise necessary to bring the vessel walls into apposition.

Either ligature or transfixion is applicable only when a material segment of the artery is exposed and sufficiently free from adjacent important structures. When the dissection necessary to obtain this vascular exposure would invite extension of the infection or jeopardize adjacent structures, we have recourse now to another of the later developments of vessel technic, closure of the divided vessel ends by suture. This suture carefully avoids all perivascular structures. Closure of the vessel end by suture is not to be confused with the suture "en masse" of uncontrollable bleeding points. The latter maneuver in the presence of infection is distinctly to be deprecated.

While we are discussing the question of infection, we must mention that drains are rarely indicated in the management of vessel wounds. If the vessel suture or ligation has been done in a clean wound, drains not only withdraw the plastic exudate necessary for rapid healing, but also invite infection from the surface. If the wound is infected or contaminated, it should be left widely open. In these cases, drainage with closure is a compromise measure which ensnares only those who have not seen the disastrous consequences of this procedure. In case of doubt it is much better to leave the wound widely open.

3. Condition of the Distal Circulation

THE third factor in the consideration of vessel wounds is the actual or potential damage to the distal circulation. The actual damage is that directly sustained through the trauma. The potential damage is measured by two factors. First, that which may be added by increasing hematoma which shuts off the collateral supply. Second, that which is determined by the surgical sacrifice of vessel lumen incidental to the operative intervention. The viability of the part supplied by the injured vessel depends on the summation of these three factors. To estimate them one must know the importance of the vessel trunk injured to the life of the part it supplied, the abundance of the collateral circulation present to take its place, the extent of the direct damage to the vessel, the amount of hematoma pressure and the limits of effective surgical intervention imposed by destruction of tissue and concomitant infection or disease.

The pre-operative status of the circulation distal to the point of injury can sometimes be determined by careful palpation or by the Pachon oscillometer. In the presence of alarming hemorrhage, however, this determination must wait on the control of the bleeding. In the extremities it can then be determined only during the first part of the operation, when provisional control has been substituted for the tourniquet. The provisional control is cautiously released and the amount of impairment of distal circulation is ascertained. From this apparent impairment must be subtracted the factor of arterial spasm, which may be present in greater or lesser degree after vessel injuries or irritations by provisional control methods. The amount of extramural occlusion by hematoma pressure must also be discounted. Even with these and other factors such as the size and importance of the vessel and the collateral supply evaluated, one may still be led into serious error by the retention of a partial stream of flow in a vessel with a large lateral wound. A final analysis can be made only at the operating table with the vessels involved completely exposed, and the extent of the damage directly observed. Then only can a decision be rendered as to how much of the circulation is left, how much more may be sacrificed in the course of the surgical procedure, or how much must or can be restored in order to preserve the life of the distal part.

In unimportant vessels or where collateral circulation is abundant, it is better not to indulge in reparative methods. A simple obliterative method should then be used. In major vessels, on the contrary, reparative suture is the method of choice. In certain locations we know that gangrene is more likely to occur than in others. Gangrene is much more likely to occur after main trunk injuries of the lower extremity and are rare after comparable injuries in the upper extremity. The most vulnerable sites of all are above the profunda branch of the femoral, in the popliteal region and above the profunda branch of the bra-

chial. In these locations especially are reparative methods desirable.

At any point, in the presence of infection or of diseased vessel tissue, reparative suture should not be used. Thrombosis practically always follows and vitiates the reparative surgery. The added manipulation required for the reparative suture only serves to aggravate the infection. It is much safer under these circumstances to resort at once, even with major vessels, to obliterative control, even though one knowingly faces the possibility of subsequent gangrene.

Restorative sutures are put in with the simplest possible technic and the least amount of manipulation. If the wound in the vessel is uneven, its edges are freshened before suture. In small lateral wounds the continuous cross suture (See McNealy, Section on Surgery of Aneurysms, Lewis' System of Surgery) is easily applied. If the lateral wound exceeds two-thirds of the circumference of the vessel, the accepted policy is to complete the division of the vessel, freshen the ends and perform an end-to-end anastomosis. If the resection required exceeds three-quarters of an inch, in most situations it will be impossible to effect a direct anastomosis without excessive tension. This can be obviated only by inserting a vein transplant or by using a Tuffier tube. These may carry the main blood flow for a sufficient period of time to allow the adequate development of collaterals but are very hazardous procedures.

The proper management of the accompanying undamaged veins is still in question. Previous to 1913 it was a rather well founded idea that in wounds of large arteries, the concomitant ligation of the accompanying vein led to gangrene of that extremity more frequently than did ligation of the artery alone. In 1913, the attention of Makins, the British surgeon, was called to the fact that in the treatment of arterio-venous aneurysms, fewer cases of gangrene developed when the vein was also ligated than when the artery only was occluded. The studies of Oppel, Wieting, Holman and Edwards and Brooks and Martin confirmed the observation—that simultaneous vein ligation would be of considerable value in reducing the frequency of gangrene when the artery was or had to be obliterated. This conclusion has been almost universally accepted.

The mechanism whereby gangrene is diminished is still in dispute.

Wilson summarizes the theories propounded as follows:

1. Ligation of the vein restores the "balance of the circulation." This implies a belief that in occlusion of the artery alone, the capacious main vein affords a too ready outlet for the diminished quantity of blood reaching the part below the occlusion. The blood tends to supply mainly the proximal tissues of this part and is not dispersed to the distal tissues. There is thus a condition of unbalance between inflow and outflow which it is claimed can be corrected by venous occlusion. A closely allied idea is that venous ligation keeps the blood in longer contact with the tissues which are presumably enabled thus to extract more oxygen from it.

2. The theory formulated by Brooks of a more homogeneous distribution of the arterial blood. The main favorable influence according to him is the raised intravascular pressure which serves to keep the capillaries patent in areas in which they would otherwise collapse and this distributes the arterial blood more uniformly throughout the tissues.

3. The theory of the development of a "richer collateral bed" is the conclusion from certain injection experiments.

4. The theory of "masked sympathectomy" advanced by Leriche and Fontaine. They believe that the initial rise of limb arterial pressure after venous ligation is associated with a transient peripheral vasoconstriction which is succeeded in some minutes by an active vasodilation, and that these effects are produced by reflex action along sympathetic nerve fibers.

The results of Wilson's own experimental studies were not in accord with the previous experimental work on the subject. They do not support the current belief that ligation of the main vein diminishes the incidence of gangrene which follows ligation of the main artery. His results may possibly lead us back to the older views which encouraged preservation of the concomitant vein. These conflicting views from reliable sources make it inadvisable, however, to take an arbitrary stand about it until more evidence is accumulated.

4. Complicating Injuries

IN INJURIES to large blood vessels, surgical management should be concentrated primarily on the care of the blood vessel wound. The care of concomitant injuries to tendons, nerves and bones should usually be relegated as much as they safely can be to a later period. When the management of the blood vessel wound requires obliteration of its lumen, the primary acute deficiency in blood supply makes the success of primary nerve or tendon suture dubious. When the blood vessel lumen is restored or reconstructed by suture further extensive manipulation in the vicinity in an effort to resuture the soft tissues accurately jeopardizes the vessel repair upon which the success of the whole operation primarily depends.

5. Postoperative Care

WHILE much depends on a nice choice of operative procedures in taking care of the vessel wound and adjacent parts, too often the advantages thereby gained are promptly lost by injudicious postoperative care. In clean cases the details of postoperative care are designed to maintain the part simply in a physiologic norm. The extremes of management varying from unrestricted activity to the rigid immobilization and encasement which was so popular a generation ago, are to be avoided.

The part is kept in a comfortable position and a small amount of activity is encouraged. In the

extremities this activity should be confined to the small acral muscles. It should not include gross movements of flexion and extension which puts a dangerous strain on suture lines and invites the loosening of emboli. The maximum benefits are gained when movements are not pushed to the point of fatigue. The part is protected from decubital pressure, especially over the bony prominences. It is kept warm but extreme caution is exercised to avoid burning or maceration. The deficient blood supply lowers the resistance of the tissues to thermic insults.

In infected cases, dependent and adequate drainage must be maintained. Full advantage is taken of the position in which the part is placed to maintain dependent drainage. Warm, moist dressings are used sparingly because the heat is difficult to stabilize, the moisture leads to maceration and the dressing as a whole serves to obstruct free drainage. Frequent irrigation or Dakinization is probably much more advisable.

The final result of the management of acute vessel injuries requires not only the control of hemorrhage and of infection and the reduction to a practical minimum of the amount of vascular loss, but the maintenance also of the life of the part supplied by the vessel involved. In many cases the amount of vessel substance which is lost or which must be sacrificed to save the patient from fatal hemorrhage or infection is more than the limb can spare. Survival of the part is then secured only by the rapid and abundant development of collateral channels. Successful results were obtained in blood vessel surgery long before the importance of this collateral circulation was recognized. Even today in many cases in which some intricate method of vessel wound management is instituted, success is obtained not by virtue of the ingenuity of the surgical procedure but by the incidental generous development of collateral vascular channels.

The most recent major contribution to blood vessel surgery is the recognition of the importance of the collateral flow, and the discovery of methods which stimulate collateral development to its greatest possible maximum. All adjuvants to the development of collaterals such as postural exercises, intermittent application of heat, intermittent venous congestion, or vasoconstricter paralysis by nerve block are recommended as elective features of the postoperative program. Active encouragement in the use of these methods will reduce the percentage of postoperative gangrene and improve to some extent the results obtained by our surgical ancestors.

Belongs to the Business

THE medical counselor . . . it is hoped, can save the man who consults him from making costly mistakes, including the mistake of neglecting illnesses which will become far more serious if they are not promptly treated.* As a further step toward reducing the costs of illness the counselor will make frequent inspections of the plant with a view to correcting any unhygienic conditions which he may discover. Though the service is limited to *Tribune* employees and their families, the plan has been announced publicly in the belief that it may prove of interest to medical men, employers, and employees, generally. Of late years the tendency has been to assume that the government must bear the responsibility and the taxpayers the burden of protecting the individual from all the misfortunes that flesh is heir to. We are satisfied that the extension of this doctrine will be unsatisfactory for all concerned. Costs will be needlessly high and political influence will make for inefficiency and administrative incompetence. The task properly belongs to the business corporation in its capacity as employer. It will pay the bill or most of it in either case, but if it administers the various welfare plans they will be handled more considerately and more efficiently than if the burocrats are allowed to run the show and take their percentage.

* From an Editorial, "The Medical Counsellor," in *Chicago Tribune*, January 4, 1938.

Fractures of the Forearm

—*Both Bones*—

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THE tremendous increase in recent years in the number of fractures, and the concomitant increase in their severity, make it imperative that the physicians caring for these injuries familiarize themselves with the common principles of bone growth and repair.*

Bone is not only a substance giving form and support to the body, but it is as well a storehouse for calcium. It is rich in blood vessels, nerves, and lymphatics, and the marrow in the long bones is one of the chief manufacturing sites of both the red and the white blood cells.

The growth and repair of bone is controlled by two general factors, e.g., local and general.

The more important of the local factors are, blood clot, apposition of the ends of the fragments, good free circulation, periosteum, callus formation, cellular production and destruction—and, presumably, the pressure or absence of calcium itself.

General, or constitutional factors, entering into the growth and repair of bone are age, endocrine secretions, especially the parathyroid gland, the presence or absence of focal or general infections, such as tuberculosis, syphylis, chronic blood dyscrasia, diabetis, chronic nephritis, and the general well-being of the patient.

As a rule the bones of the forearm have a bountiful blood supply. This is a distinct attribute towards union of the broken fragments.

There is little if any difference in the basic principles underlying the care of a fracture if it be in an adult or in a child. Reasonable apposition of the ends with careful fixation for the proper period

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of time will almost surely give a good end result.

In fractures of the ulna and of the radius certain anatomical factors must be borne in mind.

In the first place the ulna itself is largely subcutaneous throughout its entire course. It is, therefore, easily palpable. In the second place it is large and strong in its upper half. It is round and small in its lower half. It is practically a straight bone. It may be thought of as the continuation downward of the humerus itself, with which bone it is connected to give fixation and stability to the elbow joint.

Conversely, the radius is large and thick in its lower half; it is more round and smaller in its upper half. The lower half is largely subcutaneous whereas the upper half is well-covered by the large upper forearm muscles. The lower end of this bone, with certain of the carpal bones, makes the wrist joint what it is. The bone may be thought of as the upward projection of the hand itself. The shaft of the radius is bowed laterally to enable it to rotate around the ulna.

An important factor to bear in mind in treating fractures of the bones of the forearm is the interosseus space. It is widest when the forearm is midway between supination and pronation, and it is narrowest when the forearm is in a state of complete pronation. The interosseus membrane divides the forearm into an interior and posterior compartment. The flexor and the pronator group of muscles lie largely in the anterior plane, while the extensor and the supinator group lie largely in the posterior plane.

The insertion of the tendon of the pronator radii teres muscle is one of the most important anatomical facts for consideration in caring for fractures of the shaft of the radius. When both bones are fractured consideration should be given to the best possible alignment of the ulna in its upper half and conversely to the radius in its lower half.

Where the shaft of one or the other, or both, of these bones, is broken in its or their entirety, we make it a practice to immobilize the joint above as well as the joint below, regardless of whether reduction be secured by the closed method or by open operation.

Inasmuch as it is easier to obtain pronation than it is to obtain supination in the after care of forearm fractures, it is our practice as a rule to put most of these cases up in position of full supination.

For the sake of brevity, fractures of the olecrannon process and fractures just above the wrist joint are not discussed in this paper. This leaves, therefore, fractures of the shaft of the ulna, of the radius, as well as fractures of the head and neck of the radius, and fractures of the shaft of both the forearm bones, for us to give general consideration to.

Palpation, in particular, and examination, in general, are both painful and frightening to the average patient. It is, therefore, our practice to make the diagnosis largely by the x-ray.

Fractures of the shaft of the ulna, in which there is little if any displacement, are best treated by proper padding and simple immobilization, including both the elbow and the wrist, with the arm in midposition and the elbow at about 90° flexion.

ONE who is called to treat an ulna fracture with displacement of its fragments, should, of course, under complete local or general anaesthesia, make an honest effort to realign the bone

Fig. 1-A. Fig. 1-B. Fig. 1-C.

(A) Fracture both bones right forearm, female adult. (B) Same patient, picture made two months later, two days after open operation with reduction of fracture and bone peg in both bones. (C) Same patient, five months later, peg in the ulna completely absorbed and the one in the radius almost so. Perfect results a year later

ends by manipulation. If this be unsuccessful, and it usually is in our hands, we then make a short incision over the line of fracture, retract the soft parts and skid or slide the bone ends together. If there is a tendency for one or the other of the fragments to move, we fix them, end to end, either with a bone peg or kangaroo tendon. A cast is then applied, a window is cut over the operative site for subsequent dressing, and the fracture is then treated as above outlined.

Adults should wear their splints for eight to ten weeks, children for six to eight weeks. The fingers should be left free from the plaster in order that finger motion might be started within a day or two after the application of the immobilizing dressing.

In treating fractures of the upper half of the shaft of the ulna one should always suspect and look for a dislocation of the head of the radius. In some instances the orbicular ligament is torn, or ruptured, thereby permitting the head to get out of its normal anatomical position. If it is impossible to reposition the head, it may be necessary to open the arm and suture the ligament around the head of the radius to keep it in its proper place.

Fractures of the head and neck of the radius are more common than generally supposed. These injuries frequently complicate severe fractures about the elbow joint. They may be simple fissures involving only a part of the head or the neck, or the break may extend entirely through one or the other of these structures. The fragments may or may not be displaced. Comminution of the head itself is not infrequent.

Where the head or neck is fissured or even broken through in its entirety, in the absence of displacement, conservative treatment is the one of choice. It consists of a splint applied to the dorsal surface of arm and forearm down to the fingers with the elbow in a position of moderate flexion and the forearm completely supinated.

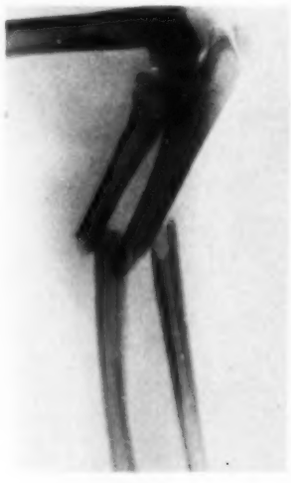

Fig. 2-A.

Fig. 2-B.

(A) Fracture both bones left forearm at the junction of the middle and lower third with overlapping. Impossible to align under fluoroscope. (B) Same patient, picture made two days after open operation, bone peg inserted in each bone. Results a year later, complete anatomical and physiological function

When the radial head is comminuted or when a piece of the head as large as a third is broken off and displaced, or when the head itself is displaced from a fracture through the neck, open operation with resection of the head is indicated. The postoperative treatment consists of starting motion at the end of 10 days and continuing it until there is complete restoration of flexion, extension, pronation and supination. In children, owing to the epiphysial line, resection should be the last resort. Reposition should first be tried, even by open operation.

The shaft of the radius in adults is frequently broken. In children it is often involved in connection with green-stick fracture of the corresponding ulna.

Fractures of the radial shaft are most frequent in the middle and lower third. They are often compound, occasionally comminuted. The character of displacement depends upon whether the fracture is above or below the insertion of the pronator radii teres. When above, the upper fragment is supinated and drawn forward and the lower fragment is pronated and drawn inward toward the ulna. When below, the upper fragment is pulled forward by the biceps and forward and inward by the pronator teres.

In fractures of the radius supination is largely impossible. When the head of the bone does not rotate, when the radius is pronated and supinated. a fracture of the radial shaft is unquestionably present.

The treatment for simple fractures of the shaft above the insertion of the pronator radii teres, consists of immobilizing the forearm, elbow and wrist in position of moderate flexion and full supination.

For fractures below the insertion of this muscle, the forearm is put in position of moderate flexion, midway between pronation and supination, and maintained thus for a period of six to eight weeks in adults.

Fractures of the shaft of the bone with marked displacement, in which reduction is difficult or impossible, are, of course, best handled by open operation, the bone ends being held together with bone peg or kangaroo tendon. The soft parts are then closed layer by layer and immobilization is carried out with the arm in the proper position, depending upon the site of the fracture.

A transverse or an oblique fracture of the radius two to two and a half inches above the wrist joint, with displacement of the fragments, is a difficult one to reduce. The short lower fragment and the intact rigid ulna make it next to impossible to reduce accurately. The procedure we use is to make a short incision, retract the soft parts, expose the bone ends and slide them together. Should it appear that the ends will not remain intact, they may be made to hold either with a bone peg or kangaroo tendon fastened through a hole bored in each end of the bone. The wound is closed without drainage; a cast is applied to the arm with full supination and a moderate degree of flexion.

Fractures of both bones of the forearm are more

frequent in children than in adults. In our series of cases the lower half has been the one broken in the majority of the cases. This fracture may result from a direct blow, in which case the bones are usually broken at the same level, or it may occur as a result of a fall upon the outstretched hand, in which case the bones are usually broken at different levels. The majority of our cases show the ulna broken at a lower level than the radius.

Many of these cases are compound. In children a goodly number are of the green-stick type. When both bones are broken and overlapped, shortening ensues because the lower fragments are drawn upward by the contracture of all the muscles of the forearm.

Fracture of both bones is more frequent than fracture of either bone alone.

When there is no displacement of the bone ends, it is our custom to apply a cast from the base of the fingers to a point well above the elbow, the arm in a mid-position or in one of supination.

When there is angulation at the site of fracture without displacement an effort should be made to insert the fingers between the two bones and by pressure endeavor to separate them; careful traction at the same time being utilized to realign the bone ends. A sugar-tong plaster is then applied, the forearm being either in mid-position or full supination depending upon the site of fracture in the radius. A well-padded short anterior and a longer posterior wood splint may be used in lieu of the sugar-tong plaster. In either instance the purpose of this is to secure sufficient force to aid in keeping the bones apart, thus counteracting the contracting force of the interosseus membrane. The circular cast is applied over the anterior and posterior wooden ones.

Fractures of both bones with marked displacement of the fragments may occasionally be reduced by prolonged and tremendous traction in the long axis of the bones. Again where there is much damage to the soft parts, beneath, with an intact overlying skin, traction may be resorted to; with the patient in bed an old-fashion Buck's extension with adhesive plaster and a Thomas splint. If, however, there be a bad compound or comminuted fracture, the method of choice would be skeletal traction, by means of a small wire through both bones just above the wrist joint, with weight enough to gradually pull the bone ends into place Repeated x-ray pictures should be made to enable one to keep watch on the ends of the bones. The amount of traction used will depend upon the size and muscular development of the individual. It should be lessened somewhat just as soon as the bone ends come together, and a straight short and long wooden splint with a cast should be applied as soon as is warranted, the position of the forearm depending entirely upon whether the radius is broken above or below the insertion of pronator radii teres.

In our opinion these traction cases should be handled in bed.

The frequency with which both bone fractures with overlapping and displacement should be operated will depend largely upon the individual surgeon. Personally we prefer the open procedure to the closed or the skeletal, other things being equal.

The open operation is easy. It can be quickly done; the time spent in bed is only a day or two at the most. It is our custom to make two incisions, one over each bone at the site of fracture. If there is any tendency for the bone ends not to remain locked, so to speak, after they are replaced, we fix them either by means of a bone peg or kangaroo tendon. Drains are not used. The wounds in the soft parts are closed in the usual way; the plaster cast is applied, the forearm in the mid-position or fully supinated, depending upon the site of the injury to the radius; and a window is cut over each operative field for subsequent dressing. These casts should extend from the mid-humeral region to the base of the fingers. They should be worn from five to six weeks in children and six to eight weeks in adults. Finger and thumb motion is

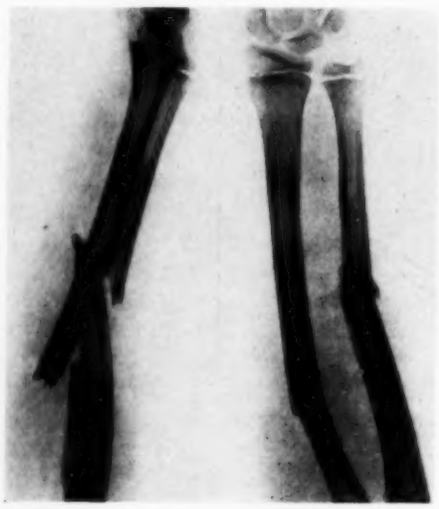

Fig. 3-A.

Fig. 3-B.

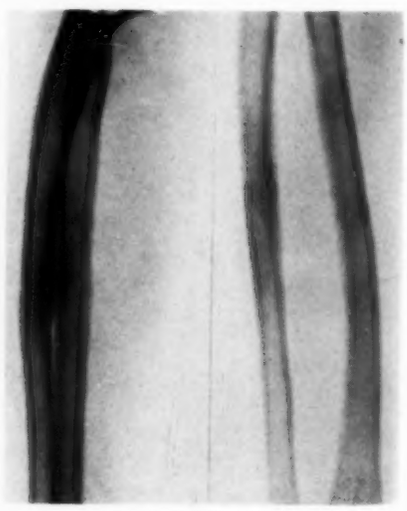

Fig. 3-C.

(A) Fracture both bones left forearm in a child of 12 with marked overlapping of bone ends. (B) Same patient, picture made two days after open operation showing bone peg in each bone. (C) Same patient, patient made year later, complete bone union, 100% arm function

FRACTURES		
1. Both bones left forearm	41 cases	12 operative
1 case—compound comminuted fracture—developed gas gangrene and had amputation of arm three days after injury		
2. Both bones right forearm	34 cases	6 operative
3. Left ulna—alone:		
Junction of middle and upper third	3 cases	0 operative
Middle third	7 cases	0 operative
Lower third	1 case	0 operative
	11	0
4. Right ulna—alone: Junction of middle and upper third	3 cases	0 operative
5. Right radius—alone:		
Head	3 cases	1 operative
Middle third	7 cases	0 operative
Middle third—mal-union	1 case	1 operative
Lower third—mal-union	2 cases	2 operative
Lower third—non-union	1 case	1 operative
Upper third	2 cases	0 operative
Upper third—mal-union	1 case	1 operative
Lower fourth	2 cases	1 operative
	19	7
6. Left radius—alone:		
Head	3 cases	1 operative
Neck and head of radius	1 case	1 operative
Upper third	1 case	0 operative
Middle third	3 cases	0 operative
	6	2
TOTAL	116 cases	27 operative

started on all our patients at the end of the second day.

In closing, permit me to say that in cases of non or mal-union operative treatment is the one of choice. It consists of exposing and freshening the bone ends and holding them together either with a bone peg or a kangaroo tendon. If there be loss of bone substance a bone graft will probably be needed.

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Trauma to the Abdomen

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IN THIS treatise on trauma we shall consider only closed wounds of the abdomen which are the undisputed province of the surgeon.* The etiology and consequences are usually so obvious in gun-shot and penetrating wounds of the abdomen that this phase will not be reviewed now. Closed wounds of the abdomen can be classified clinically as: (1) wounds of the abdominal wall with or without intra-abdominal injury, and (2) so-called subcutaneous wounds involving injury to the hollow or solid viscera.

The modus operandi, as is recognized by all, involves falls, blows, bumps, crushing injuries and so on, and requires no further discussion. Likewise, the degree of the trauma, location of the violence and conditions of the abdominal wall—whether relaxed or rigid and conditions of the intestinal tract all, theoretically at least, may have some bearing on the extent of the damage inflicted. Unfortunately, the patient is never in a position to make a choice in this detail.

In some of the most severe cases of intra-abdominal damage that I have seen the abdominal wall itself never showed a scratch or mark of any kind. In other cases however, the abdominal wall may show evidences of contusions, ecchymosis or subcutaneous hematomas, and in occasional cases, partial or complete rupture of the abdominal muscles. Intra-abdominal damage involving the solid organs such as the liver, spleen, and kidney may vary in degree from minor lacerations to severe fractures of the entire viscera. Associated therewith there is always more or less intense intraperitoneal or less frequently retroperitoneal hemorrhage. There are few clinical pictures which offer the drama which occurs in this abdominal catastrophe.

Lesions of the hollow viscera may include damage to the stomach, intestinal tract, gall-bladder or urinary bladder. The degree of the damage often cannot be determined preoperatively. Exploratory laporotomy may reveal gastric content, feces, urine or bile and thus offers a clue as to the organ involved. Again, the degree of damage may vary from simple ecchymosis to the serous coats or sometimes the submucus coats to complete rupture of the entire wall. Or the lesion may be confined exclusively to the mesentery or omentum with or without evidences of retroperitoneal hemorrhage. Tears of the omentum aside from the accompanying hemorrhage are usually comparatively inconsequential, but damage to the mesentery may consist of complete tearing of the mesentery from its

* Presented at the Annual Mid-Winter Clinical Meeting of the Central States Society of Industrial Medicine and Surgery, Milwaukee, December 9, 1938.

attachment to the bowel of extensive involvement of the circulation impairing vitality of the bowel. In discussing pathological findings of abdominal trauma, at this point, I cannot overlook mentioning the distinct entity of traumatic appendicitis, but that is a problem in iself and can only briefly be touched upon here. Lesions of the aorta or vena cava have been described. Fortunately, I have never personally encountered that catastrophe. I have, however, met with a rather unusual case of complete rupture of the femoral artery just as it crosses Poupart's ligament. This case will be discussed later in this paper.

Symptoms

VARYING degrees of shock irrespective of the presence or absence of intra-abdominal damage are usually present with moderate abdominal wall traumas. One must not, however, be misled in interpreting this initial shock as a measure of the amount of damage done. Where the initial shock is prolonged more than several hours or where it is early associated with symptoms of concealed hemorrhage, such as increased pallor, air hunger, shifting dullness and progressively falling hemoglobin, rupture of a solid viscus or tearing of a large vessel must at once be anticipated. Accompanying the initial shock, pain is always an early symptom but, again, the degree of pain is not necessarily an indication of the amount of damage. For example, in simple abdominal wall traumas pain may be a more prominent factor than other symptoms. Where visceral damage has been done the pain, if the patient is seen early, is usually localized directly over the site of the lesion but after a few hours, both with hemorrhage or perforation of a hollow organ, the pain becomes more and more generalized. Vomiting is frequently an early symptom and, in itself, is not particularly diagnostic except where it is intractable and then it is more or less indicative of severe damage. Occasionally in rupture or injury to the stomach blood will frequently be found in the emesis. Occasionally also, in damage to the sigmoid, or rectum, blood may be passed per stool. Similarly in damage to the urinary tract, pure blood or bloody urine may be found. I wish to emphasize at this point that in severe rupture of the kidney, where the ureter has been torn across or blocked, the urine itself may be absolutely blood free. Again, in ruptures of the bladder, particularly in the intraperitoneal type or where the urethra has been severed, no urine at all may be passed. With rupture of a hollow viscus progressive abdominal distention is usually seen and the determination of free gas beneath the diaphragm or obliteration of liver dullness are very important diagnostic findings. Rigidity and tenderness are two of the most constant and important finding in abdominal trauma. They are invariably present in those cases involving trauma to the abdominal wall alone as well as in those instances complicated with intra-abdominal damage. Localized rigidity and tenderness gradually becoming more widespread are suggestive of perforation of a hollow viscus. The rigidity in this type of case is usually described as boardlike and very intense whereas in lesions involving the abdominal wall per se both tenderness and rigidity have a tendency to be more superficial. I wish to admit, however, that in many cases the distinction is often times more theoretical than practical. There are, however, several fine features which I personally have encountered in this type of case, namely, if the patient is seen early and the abdominal tenderness and rigidity are more or less diffuse and generalized, I am less suspicious of intra-abdominal damage than where there is a very acutely circumscribed area of rigidity and tenderness. The latter to me would tend to indicate an intra-abdominal lesion just below the site of rigidity. Again, it has been my experience that in cases of intra-abdominal hemorrhage such as occurs both in ruptures of solid viscera or as is frequently seen in ectopic pregnancy, the abdominal tenderness is extremely superficial and even the slightest stroking or pressure of the skin would cause an inproportionate degree of pain. I am unable satisfactorily to explain this phenomena except on the basis that peritoneal irritation from blood does cause this peculiar reaction different from that caused by other intra-abdominal contaminants, such as feces, gastric contents or urine. Needless to say, pulse rate, temperature, blood pressure and blood findings as well as x-ray may afford additional evidence and help in arriving at correct conclusions.

Unfortunately, many cases of abdominal trauma are also complicated by other factors, such as fractured ribs, fractured pelvies or even skull fractures with coma. These cases often times test the surgeon's diagnostic acumen to the limit and the preoperative judgment of the surgeon is just as important, if not more so, than what is done at the time of an exploratory laporotomy. I wish to stress that in all cases of severe trauma, and particularly where patients are in coma or severe shock, careful abdominal examination should always be made irrespective of what other injuries might exist. Refinements in diagnosis as to the exact organ involved are not nearly as important as deciding early whether or not the lesion is confined exclusively to the abdominal wall or whether there is a complicating intra-abdominal injury, either hemorrhage or perforation.

I am frank to admit that in some cases a grave doubt may exist in the surgeon's mind as to whether or not any intraperitoneal lesion is present. The persistence of abdominal pain, rigidity and tenderness together with gradually increasing distention or the persistence of shock symptoms accompanied by indications of internal hemorrhage are the most valuable and important signs. When in doubt, after waiting a few hours with the persistence of the above findings, it is far wiser to do an exploratory laparotomy and find nothing rather than to neglect a serious injury or delay operative procedures until it is too late. Each instance of trauma to the abdomen is an individual problem, and one can only summarize these preceding few symptoms and signs in facilitating the arrival at a diagnosis.

The prognosis in the traumatic abdomen is always serious except where it is grossly evident that the injury is only superficial. In intra-abdominal lesions such as rupture of the viscera, the prognosis becomes geometrically more grave in proportion to the time elapsed from the injury to operation. Each hour after six greatly lessens the patient's chance for recovery until, after 12 hours, operative mortality is close to 100%. Several factors such as the number and severity of the visceral lesions and the moment of surgical intervention are principally influential in determining the ultimate prognosis. Severe massive hemorrhages are often always fatal even before operative intervention can be instituted.

Treatment

TREATMENT of closed abdominal wounds is always surgical. Where the damage is confined exclusively to the abdominal wall absolute bed rest, with the application of heat or ice, together with morphine if indicated, is about all that will be required. The initial shock naturally must be combatted and this can best be done by the application of external heat and keeping the patient in Trendelenberg position. As soon as a diagnosis of visceral damage is made, or even suspected as being present, operation is indicated. In such cases prior to operation, while the patient is still in shock or showing signs of internal hemorrhage, it is inadvisable to use cardiovascular stimulants, for fear of the danger of increasing the hemorrhage. One of my cases definitely demonstrates that while the patient is in shock and the blood pressure has dropped, clotting may result and the hemorrhage remain controlled. Intravenous solution and particularly blood transfusions are certainly vitally indicated, but only at such times as surgical preparation has been instituted or during the course of the operative procedure.

The question naturally arises, is it advisable to operate while the patient is in shock? Unfortunately, it is not always possible to distinguish between shock and hemorrhage. If one can feel fairly certain that hemorrhage is present and persisting, operative intervention reinforced with blood transfusion at the same time is always indicated even in the presence of shock. Such patients may never get out of shock and may bleed to death if left alone. I know that this is still a mooted question. Usually a mid-line incision is selected to enter the abdomen, except, of course, where one can be definitely sure that a certain organ such as the spleen, bladder or kidney might be involved. Upon entering the abdomen presence of feces, urine, etc., may definitely furnish a clue as to the site of the lesion. If a solid organ alone is involved such as the spleen or liver a splenectomy for spleen hemorrhage is usually the procedure required. Occasionally in small wounds they can be tamponed or sutured. In cases where it is difficult to tie the pedicle or where speed is particularly required, simply clamping the pedicle and removing the spleen may be done, the clamps remaining on the pedicle for probably 72 hours; and then merely loosening them without withdrawing them. In hemorrhage from the liver tamponage is usually the quickest and best method of controlling hemorrhage. As a rule sutures will tear out. It is advisable in every case of laparotomy for trauma to do a systematic and careful exploration of the entire abdomen. Each surgeon usually has his own particular method of doing this, but a thorough exploration always should be done. Needless to point out the type of procedure to be adopted will depend upon the nature and degree of the lesion. Sometimes simple closures of a single perforated area in the bowel or stomach may suffice. At other times, widespread or multiple resections will have to be done. Bladder and kidney injuries require their own special type of procedure.

Just a word as to the retroperitoneal hemorrhage associated with a fracture of the pelvis, or with rupture of a kidney, or even from other causes. In the vast majority of retroperitoneal hemorrhage where intra-abdominal damage can be ruled out operation is seldom indicated. Besides, it is extremely difficult and often impossible either to find or control the source of the retroperitoneal hemorrhage. Where a kidney has been very badly damaged or torn off, of course, repair if possible or extirpation may have to be done. It is not necessary at this time to consider further any of the general surgical principles that should be employed post-operatively for a satisfactory outcome. I might just mention that as far as the choice of anesthetic used is concerned, personally, I always prefer spinal anesthesia. Also, in many of these cases where post-operative distention is a troublesome or uncontrollable symptom 50 milligrams of novocain intraspinally will almost always work like magic.

In conclusion let me emphasize that in any closed abdominal wound prognosis should always be guarded. Each case is an individual problem and the essential thing to determine is whether or not an intra-abdominal lesion exists irrespective of whether it involves the stomach, intestine or some other organ. An early diagnosis and prompt operative intervention will lessen mortality, and, in cases of doubt, it is far better to give the patient the benefit of an exploratory laparotomy.

I want to give you, briefly, case records on a few typical cases of intra-abdominal injuries:

MISS C. S.; 20 years old; passenger in an automobile which went into a ditch and tipped over. I first saw the patient on a country highway about 10 miles from Milwaukee about a half hour after the accident. She was in extreme shock, very blanched, and showed all signs of severe internal hemorrhage. She was promptly removed to a hospital. Examination of the abdomen showed not a single mark or scratch on the abdominal wall. There was evidence of free fluid in the abdomen together with marked generalized tenderness and rigidity. This patient died just as she was put onto the operating table. A postmortem incision showed a completely fractured liver and the entire abdomen filled with blood. This case was hopeless from the minute of the accident, and demonstrates

now a very grave intraperitoneal lesion may exist without the slightest external evidence to the abdominal wall.

CASE 2; a patient of Dr. Oakland. I saw this case in consultation and operated on the patient. He was struck over the left side of the chest by a broken flywheel. When seen in the hospital he was in extreme shock with multiple fractured ribs on the left side and was showing edema of both lungs. He also showed evidence of internal hemorrhage and was extremely tender and painful, not only over the entire left chest wall but also over the left side of the abdomen and over the spleen. A diagnosis of ruptured spleen was made, but the patient was practically in extremis and, for that reason, he was left alone, at least, so far as operation was concerned. He gradually began to come out of his shock, the edema of his lungs cleared up within 24 hours, and the man's general condition appeared so much better than I felt our original diagnosis of ruptured spleen must have been wrong. He did, however, continue to show dullness in his flanks. On the third or fourth day, while in the hospital, this patient of his own accord got out of bed to go into the lavatory and, while doing so, suddenly keeled over and again went into shock. I again saw the case at that time and was ready to go back to my first diagnosis of ruptured spleen with secondary hemorrhage. A blood transfusion was given and patient operated on at the same time. It was found that the spleen had been fractured completely in two with a large, old blood clot between the ends of the fractured halves. Of course, a new hemorrhage had occurred. A splenectomy was done and, fortunately, the man recovered. This case illustrates first of all, a ruptured spleen complicated by multiple fractured ribs and edema of the lungs, which in itself obscured the picture. Secondly, a severe hemorrhage which automatically controlled itself as the patient's blood pressure and pulse dropped and he became almost exsanguinated; then a secondary hemorrhage developed after his blood pressure had risen and the patient attempted to become slightly active.

CASE 3; Mr. Peters; age 42. This patient was cutting a board on a circular saw; the saw struck a knot and forcibly shoved the edge of the board against his abdomen. I saw him within an hour after the accident. He was in some shock but not very intense. Very definite localized rigidity and tenderness in the right lower quadrant were evident. Liver dullness at that time was not obliterated. After several hours the pain as well as the tenderness and rigidity became more intense. A consultation was held with another surgeon (not an industrial surgeon) who advised against operation; thought the lesion was confined to the abdominal wall. The patient concurred in the necessity for operation. A laparotomy disclosed a rupture of the ileum about the size of a quarter located a foot from the ileocecal valve. A closure and repair were done and patient made an uneventful recovery.

CASE 4; Florence L.; eight years old. While watching an excavating machine digging a hole this little girl was accidentally struck across the abdomen by the large iron bucket. I saw her within an hour. At that time she was in intense shock. There was extreme generalized abdominal tenderness and rigidity. The abdominal wall was contused and showed ecchymosis. Treatment was given for the shock and after about three or four hours a laparotomy was done supported by a transfusion. Multiple ruptures of the small bowel were found with areas six inches long where the mesentery had been torn completely off the bowel. Multiple resections were done. This patient lived for two days and died from the effects of shock and hemorrhage.

CASE 5; William U.; carpenter. This patient is still in the hospital. He was injured on August 24, 1938, when he fell off a scaffold a distance of 20 feet landing on his abdomen. He was taken to the Emergency Hospital, a diagnosis of intra-abdominal injury with hemorrhage was made, and laparotomy done disclosing a large area of mesentery torn off the ileum with considerable hemorrhage. A resection with side to side anastomosis was done. Three days after the operation patient developed paralytic ileus. In spite of usual measures and also a Wangenstein drainage distention was unrelieved. Fifty milligrams of novocain were given intraspinally and within 15 minutes there was almost complete relief.

Two weeks after the accident the patient showed evidences of a right-sided pleural effusion. Aspirations on two different occasions showed bloody, serous fluid and 1200 cc. were aspirated. X-ray at that time showed some slight flattening of the right diaphragm but no fractured ribs. It is possible that this man sustained an injury to the diaphragm associated with his bowel damage. After the aspirations no recurrence developed and x-rays showed normal lung and diaphragm findings.

Just two months after the accident and after the patient had been dismissed from the hospital he began to show signs of unilateral left-sided distention of the abdomen and within 36 hours developed an acute intestinal obstruction. A laparotomy was done and a loop of bowel found plastered down at the site of resection causing an acute kink and obstruction. This was relieved and patient is now well on the way to recovery.

CASE 6; Walter K.: 29 years of age. On August 24, 1935, this man was cutting a piece of hard wood on a circular saw. The wood was thrown back by the saw, striking the patient in the lower right abdomen and groin. I saw the patient at the hospital several hours after the accident. There was a hematoma in the groin about the size of a man's fist. Patient was in severe shock. There was marked ecchymoses of the abdomen and upper portion of the thigh. No pulse could be felt over the femoral artery nor in the popliteal space nor in the dorsalis pedis artery. His abdomen was rigid and tender in the right iliac area. A preoperative diagnosis of severance of the femoral artery was made with possible intra-abdominal injury. A

blood transfusion was given at the same time the patient was operated on. Operation disclosed that the femoral artery had been sheared off at the pubic bone, the proximal end showed a blood clot protruding from the lumen, and the distal end of the artery was separated from the proximal by an inch and a half to two inches. Both ends of the artery were ligated, as no repair was possible. A laparotomy was done at the same time but disclosed no rupture of the bowel although the serous coats showed petechial hemorrhages with a rather extensive retroperitoneal hemorrhage. It was anticipated that a complete amputation or disarticulation of the thigh might be necessary at a later date. However, after waiting for demarcation to occur, it was surprising to note after several days that dry gangrene had developed and did not extend upward beyond the knee. An amputation was done about four inches above the knee which resulted in perfect healing. Patient continued making an uninterrupted recovery.

Traumatic Appendicitis

MENTION has previously been made in this paper of the distinct entity of traumatic appendicitis.[1] The time allotted to me will not permit a lengthy discussion of this vital subject but I, briefly at this time, want to emphasize its existence and character.

It must be obvious to all that if trauma to the abdomen can result in perforation or explosion of any of the hollow viscera, there is no valid reason why at times the appendix should be spared.

Briefly, the abdominal cavity and digestive tract are for all practical purposes a closed space within a closed space and are both governed by and respond to the laws of force, pressure, and displacement of liquids and gases. Normally, the variations in this intra-abdominal and intra-intestinal pressure are progressive and moderate in degree with the elements of accommodation functioning without disturbance. Sudden changes in the intra-abdominal and intra-intestinal pressure may cause acute over-distention of the appendix with material forced out of the suddenly distended cecum. This may result in over-stretching of the walls with minute mucosal abrasions and subsequent infection, or fecal concretions, and so on, may become impacted partially or completely obstructing the lumen, or fecal concretions may be forcibly driven through the appendiceal wall. If the force is sufficient, immediate rupture of the appendix may occur. Or local lacerations where the appendix is compressed against the iliac bone may occur. That latter is rather the unusual type of traumatic appendicitis.

In order to classify appendicitis as traumatic, we have formulated the following postulates:

1. There must be absolute freedom of abdominal complaint associated with nausea, vomiting and tenderness preceding the trauma.

2. The direct trauma must be severe and forcible involving directly the abdominal wall, especially the right half.

3. The indirect trauma as a fall or strain must be violent, acute and unexpected.

4. The symptoms must appear immediately following the trauma, indicating localization to the right lower abdomen. The symptoms must be persistent, and progressive assuming the clinical symptoms and signs of acute appendicitis.

I usually refer to these latter as the four "P's" Pain, Prompt, Persistent (at least, more or less persistent) and Progressive.

These criteria aptly characterize this syndrome and serve as a guide in the classification of appendicitis associated with trauma.

1. Partially quoted from an article in *Am. J. Surg.*, March, 1936.

Spinal Fractures

—Problems in Diagnosis and Treatment—

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A CLEAR understanding of the proper diagnosis and treatment of vertebral injuries must be preceded by an understanding of the anatomical differences existing in the cervical, dorsal, and lumbar regions.* In the cervical vertebrae (Fig. 1) the articular processes lie practically in a horizontal plane; the transverse processes are short and have a foramen for the passage of the nerve roots; the spinous processes are bifurcated above, but are fused in the lower cervical region. The thoracic vertebrae show a distinct difference in that the articular processes assume a more vertical position (Fig. 2) and thus dislocation of one vertebra or another is rendered more difficult than in the cervical region; the transverse processes show a marked elongation, with facets on all except the eleventh and twelfth ribs for articulation with the tubercles of the ribs; the spinous processes are long, directed obliquely downward and overlap from the fifth to the eighth; the bodies increase in size from above downward and are distinguished by the presence of facets on the sides for articulation with the ribs. In the lumbar region are the largest segments of the movable portion of the vertebral column (Fig. 3). These are distinguished anatomically by the absence of a foramen in the transverse processes and by the absence of facets on the sides of the bodies.[1] Here too, we have the hardest and softest bone in the body; the pedicles and laminae are composed of extremely compact bone, while the bodies are made up of spongy bone. Thus it is readily understandable why the bodies of these vertebrae compress like an accordion when subjected to violent hyperflexion.

The ligaments of the vertebral column play a most important part in the consideration of spinal injuries, inasmuch as movements of the vertebral column are limited by these ligaments. The individual vertebrae move only slightly on each other, but when this slight degree of movement between the pairs of bones takes place in all the joints of

* The subject matter of this article was presented before the Central States Society of Industrial Medicine and Surgery.

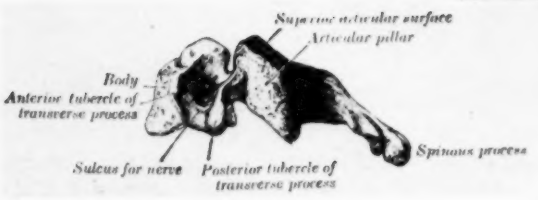

Fig. 1 (Above)
Sideview of a typical cervical vertebra

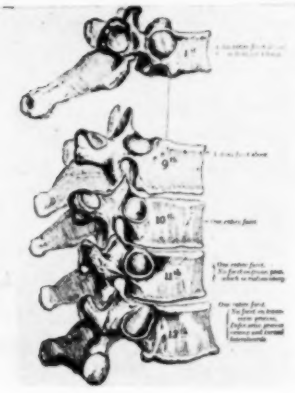

Fig. 2 (Right)
Peculiar thoracic vertebrae

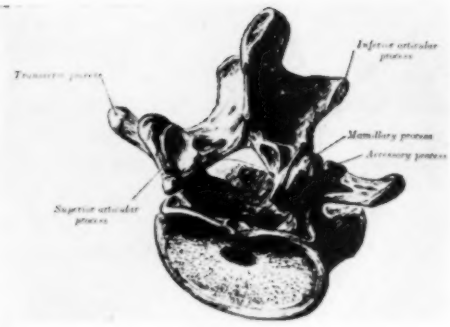

Fig. 3.
A lumbar vetebra from above and behind

the vertebral column, the total range of movement is considerable.

A. Ligaments of Articulation of Bodies

THE ligaments of the articulations of the vertebral bodies are:

1. The anterior longitudinal ligament;
2. The posterior longitudinal ligament, and
3. The intervertebral fibro-cartilages or intervertebral discs.

The anterior ligament is a broad, strong band extending along the anterior surface of the vertebral bodies from the axis to the sacrum. It is thicker in the thoracic than in the cervical and lumbar regions, and somewhat thicker opposite the bodies of the vertebrae than opposite the intervertebral discs. The posterior ligament is situated within the vertebral canal, and extends along the posterior surface of the vertebral bodies from the axis to the sacrum, being thicker in the thoracic than in the cervical and lumbar regions. The intervertebral discs are of extreme importance in a consideration of vertebral fractures and injuries since they form the chief bonds of connection between the vertebrae. One fourth of the total length of the vertebral column is made up of the discs, but this amount is not equally distributed between the various vertebrae, the cervical and lumbar portions having, in proportion to their length, a much greater portion with the result that these parts possess much greater pliancy and freedom of movement. In structure these discs are composed of a peripheral denser annulus fibrosus and a softer pulpier central portion, the nucleus pulposus.

This latter consideration of exact structure has been noted especially since Schmorl[2] described his characteristic nodes which developed after the escape of the nucleus pulposus into the body of spongy bone. Noteworthy, too, in this connection is the presentation by Olin[3] in which 84% of his 56 cases showed involvement of the nucleus pulposus with the fracture.

B. Ligaments of Articulations of Vertebral Arches

THE ligaments of the articulation of the vertebral arches are:

1. The joints between the articular processes of the vertebrae are enveloped by capsules lined by synovial membranes; these capsules are thin and loose especially in the cervical region.
2. The ligamentum nuchae, a heavy fibrous band extending from the occipital protuberance to the seventh cervical vertebra.
3. The supraspinal ligament, a strong fibrous cord extending from the seventh cervical vertebra to the sacrum.
4. The ligamenta flava, connecting the lamina of adjacent vertebrae; their elastic character serve to preserve upright posture and assist the vertebral column in resuming normal position after flexion.

Fig. 4.
Arthritic destruction, cervical vertebra

Fig. 5.
Fractured sixth cervical vertebra

Fig. 6.
Dislocated fifth cervical vertebra

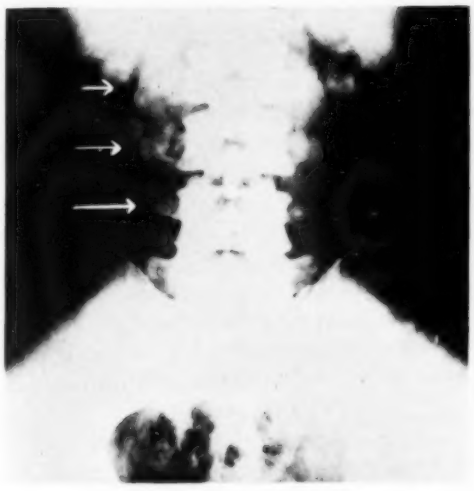

Fig. 7.
Fractured transverse process

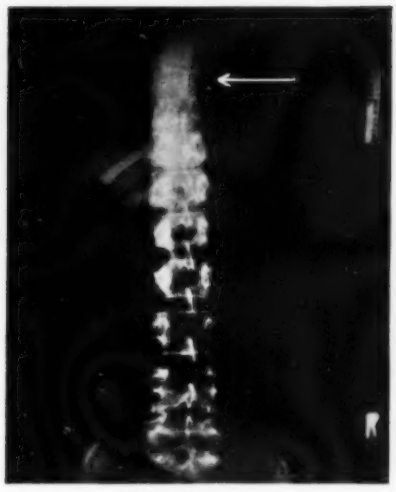

Fig. 8.
Compression one-half body of tenth dorsal vertebra

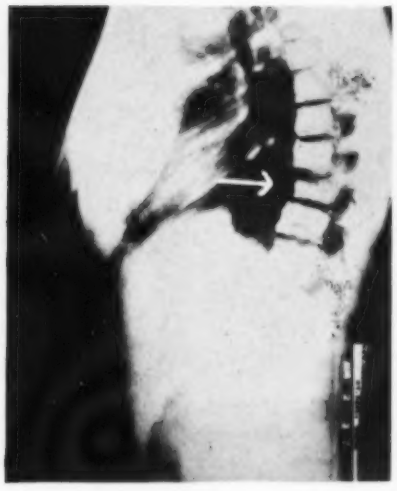

Fig. 9.
Compression one-half body of tenth dorsal vertebra

5. The interspinal ligaments, thin and membranous in character, merely connecting adjoining spinous processes.

6. The intertransverse ligaments, interposed between the transverse processes and having a definite function mainly in the thoracic region where they are intimately connected with the deep muscles of the back.

Thus, when one considers the variety and strength of these ligamentous cords and bands, it is possible to understand the variety and yet difficulty of injury to the spine.

Diagnosis of Injuries

IMPORTANCE OF HISTORY:

With a knowledge of the anatomical differences in the various segments of the spine, an accurate history will often aid in localization of the injury. All compression fractures result from hyperflexion; this "jack-knifing" of the spine may result from cave-ins, falls, auto injuries, or concussion—i.e. falling straight down for a distance and landing on the feet. Most compression fractures in reported series of cases[4,5,6] occur in the first and second lumbar and eleventh and twelfth dorsal vertebrae. The cervical region is next in order of frequency, with the sixth cervical vertebra most commonly involved. These two regions, the sixth cervical and first lumbar, are the prominent points of hyperflexion of the neck and back respectively. Jefferson,[7] in reviewing 2,006 reported cases, found a slightly higher percentage of cervical than lumbar fractures with a numerical ratio of 250 cervical to 225 lumbar. Roberts[8] also found the sixth cervical vertebra was the one most commonly fractured. In this cervical region, hyperflexion may frequently result in dislocation, with or without fracture of the articular processes. The transverse processes are very strong here, so that injury occurs usually only from a violent direct blow and then the force of the trauma is transmitted to the bodies, discs, or articular processes. Figs. 4 and 5 shows two illustrative cases, the first exhibits arthritic destruction, the second extensive fractures; symptoms, both resulting from falls, appeared similar. Fig. 6 illustrates the fact that with a fracture of the pedicle in transverse processes dislocation of the body is a rule. It should be em-

Fig. 10.
Third lumbar compression fracture

Fig. 11.
Hyperextension, first lumbar and eleventh dorsal compression fractures

Fig. 12.
First lumbar compression fracture before treatment

Fig. 13.
First lumbar compression fracture after treatment

phasized that the odontoid process should always be x-rayed in suspected cervical spine fractures because a fracture in this region, if undiagnosed and untreated, may result in non-union and subsequently lead to death by dislocation of the atlas on the axis. In the cervical region, also, a violent direct blow may often fracture the spinous processes and again, since the force is transmitted to the bodies and articular processes, one must suspect a possible dislocation and dislocation may exist even without paralysis or any sign of actual nerve injury.

Direct, violent trauma to the dorsal spine is also very likely to produce injury to the body and articular processes, and if hyperflexion is a part of the traumatic entity, a typical wedge shaped deformity is produced, such as is so commonly seen in the lumbar region. Fractures of transverse processes and spinous processes are as common as any type of vertebral fractures and are usually due to direct trauma exerted in the lumbar region (Fig. 7). On the other hand, fractures of the articular processes without any other involvement are extremely rare and are produced only by a combination of hyperflexion and axial deviation (a twisting motion while the spine is flexed). (Figs. 8 and 9). In this respect, Bailey[9] emphasizes the importance of differentiating articular process fractures from anomalous fissures. Thus it can be seen that the history of the mechanism of spinal injuries is most important, for it enables one to suspect what type of fracture may occur and lead to more prompt and accurate diagnosis, even before the x-ray examination is made. As a consequence, the immediate handling of patients can be performed with a minimum of unnecessary trauma.

Fig. 14.
Taylor brace

II. Symptoms:

The outstanding subjective symptoms of cases without cord involvement are, first of all, pain, usually pronounced in cervical injuries, and greatly increased by movement. Fractures of transverse processes may produce only slight pain—it is however, persistent and increased by exercise. Referred pain is most commonly associated with cervical injuries where root pressure may be made by fractures which involve the foramina of the transverse processes. Again it is well to remember that in many cases symptoms due to injuries in other parts of the body may dominate the picture so completely that a vertebral fracture is not readily suspected until later when the pain in the spine is noted as being persistent.

Fig. 15.
First lumbar dislocation fracture treated with pelvic girdle and leg braces, after hyperextension in bed

Fig. 16.
Same case after physiotherapy and massage, no braces

As examples we may cite the fact that one patient complained of pain over the sternum because of a fracture of the sternum itself, but did not mention his dorsal region where a compression fracture had occurred. Fig. 10 shows an extensive comminuted compression fracture of the third lumbar vertebra which the patient complained of not at all because of severe pain due to bilateral comminuted fractures of the os calcanei. With compression fractures, a backache localized over a relatively small area is the commonest complaint and in the lower lumbar region may simulate almost exactly the complaint made due to lumbosacral and sacro-iliac strains.

Weakness is the next most frequent complaint. Patients are usually unable to continue with their work, though in some instances of fractures of lumbar transverse processes, the individuals continued with their work for several days.

III. Objective Findings:

A. Rigidity and spasticity of the muscles is present in the area overlying the bony injury.

B. Gibbus, or some other deformity—this is an outstanding objective finding with compression fractures and dislocations; it varies with the degree of injury and is most pronounced when the spine is flexed. We have found this deformity palpable in all cases where the normal curve of the spinous processes is broken.

C. Tenderness, localized over the injured vertebrae is to be elicited usually by pressure on the spinous processes.

D. Limitation of movement is usually found because the muscles splint the area involved in the fracture.

IV. X-Ray Findings:

The x-ray findings are of prime importance in the complete diagnosis of spinal fractures because, as we have pointed out, the symptoms and objective findings may not do more than give one a clue, and the final diagnosis is made only when a proper series of roentgenograms has been read. Anteroposterior and lateral views are both necessary, and frequently oblique views will show the pedicles, articular processes, and laminae to advantage. Giles,[10] in speaking of convincing evidence of vertebral accidents, states: "A good lateral view will not infrequently be the deciding factor."

X-ray, then, is often the only method of differentiating between fracture and disease, and is the only accurate guide in determining the reducing and healing of the fracture.

Treatment

AT THE present time, everyone is agreed that there is but one type of treatment in compression fractures, namely, hyperextension. The method of application, however, has been somewhat varied. Some lay the patient prone on the abdomen and suspend the hips.[11] Other operators raise the head and shoulders and apply a body cast in this position of hyperextension.[12] Still others reverse the procedure and, with the patient lying on his back, on a frame, drop the head and feet to produce hyperextension in the desired area of the back.[13] In any of the methods which employ application of a body cast to maintain hyperextension, the cast must extend from the clavicles to the symphysis anteriorly and from the seventh cervical vertebra to the sacrum posteriorly.

We have found that in older individuals who may be partially debilitated, or in patients with concomitant involvement, such as fractured legs, feet, or internal injuries, it is much more comfortable for them to go without application of a plaster body cast during the period of enforced bed rest. For this reason we have applied a type of hyperextension that is available in any hospital, and a type requiring no special equipment or apparatus other than a regular surgical bed. The patient is placed with his head at the foot end of the bed, and upon elevating the knee support with the crank, hyperextension is produced in the lower dorsal and upper lumbar region where it is most often required. Further, by keeping the patient's head close to the foot of the bed and by elevating the support as far as it will go, it is possible to produce hyperextension even in the lower lumbar region. Fig. 11 illustrates the application of this principle to a compression fracture of the lower dorsal vertebra and upper lumbar vertebrae; it will be noted that this procedure permits the use of a regular mattress which minimizes the development of pressure sores and greatly facilitates nearly every aspect of general nursing care. During the time the patient is in this position of hyperextension, movement of the extremities and all joints except in the affected part of the spine may take place.

As long as we maintain hyperextension in the treatment of compressed vertebrae, we fulfill Boehler's[14] principles of correcting the displacement and holding it in good position long enough for bony union, while maintaining exercise of the limbs and the rest of the body to a full extent. Further, it can be predicated that this type of treatment adequately corrects the condition of the strong anterior longitudinal ligament which is loosely folded forward when hyperflexion occurs; hyperextension puts this ligament on a stretch and thus the stress on the ligament itself helps to correct the deformity in the spine.

Figs. 12 and 13 show compression fracture of first lumbar vertebra before and after this type of treatment.

Fractures and fracture dislocations of the cervical spine should be corrected immediately. This is accomplished by placing the patient with his head over the edge of an operating table and exerting traction in a horizontal direction, counter traction being maintained by the shoulder braces on the table. In cases seen late, and in those in which immediate reduction cannot be accomplished, the method of skeletal traction as proposed by McKenzie[5] and Crutchfield[15] is most efficient. When reduction has been ascertained, a plaster of Paris cast is applied from the head to the symphysis in front and to the sacrum posteriorly in order to maintain correct position. The cast is well moulded over the iliac crest so that the weight is carried in this region rather than on the shoulders. Later, a moulded leather brace may be fitted and worn (Fig. 14).

Cord involvement is usually caused by a displacement of the body of a vertebra or a fragment thereof resulting from a fracture of the pedicle or lamina. This may result in:

1. Total severance of the cord,
2. Hemorrhage,
3. Pressure upon the cord.

Hemorrhage may be extra-dural, or into the cord substance, i.e., an hematomyelia, which may extend for several inches from the site of the injury. Hemorrhage also may produce late symptoms due to cystic formation in the cord. Pressure necrosis of the cord may result from Schmorl[2] nodes, exostoses from vertebral bodies, or extrusion of intervertebral discs; and any of these conditions may be caused by too early weight bearing in compression fractures, which, when unprotected lead to angulation with cord involvement.

Kümmel's disease, the existence of which is disputed by some, is the term applied to the condition of collapse of a body of a vertebrae with no preceding history of trauma. This was first noted by H. Kümmel[16] in 1891, and reported by him in 1895; his x-rays show a loss of intervertebral spaces, (but lateral views are not shown).

With actual cord pathology it is well to have neurological consultation when possible. However, anyone can discover the level of motor and sensory loss, and can observe such prognostic signs as the priapism which is produced commonly by cord section in the cervical region. Further, the use of the Queckenstedt test is of value in determining whether there is obstruction within the neural canal. The reverse Queckenstedt test may be performed with one needle in the sacral hiatus and another in a lumbar interspace attached to a manometor; fractions of 1% procaine, 10 cc. each are introduced through the sacral needle, the extra-dural pressure so exerted causes a rise in the manometer. However, if there is extrusion of an intervertebral disc, a sudden severe pain is experienced by the patient and injection will have to be discontinued. Normally 40 to 50 cc. may be administered without pain. Love[17] administers iodized oil intra-spinally when the reverse Queckenstedt is positive.

Cord symptoms due to pressure and not actual severance disappear on removal of the cause and subsequent re-establishment of circulation. Laminectomy is indicated, however, only when a fragment of bone, extruded disc, or exostosis is the cause of the symptoms, and is a useless and dangerous procedure in cases with complete cord section due to dislocation of a vertebral body.

The results of actual cord pathology include muscle atrophy, stiffening of the joints, loss of sphincter control, circulatory changes with trophic disturbances such as decubiti and ingrown nails, rapid infection in devitalized areas, and the development of bladder and kidney infections which may require heroic and adequate treatment if the patient is to be spared a lifetime of urinary complaints.

Treatment is largely symptomatic, but in these cases also, hyperextension is of value so that when fixation and healing occur at the site of the fracture, the smallest amount of deformity results. Further, the method of applying hyperextension as we have described it is doubly advantageous in this type of case because physiotherapy is of such importance in maintaining some degree of muscle and joint movement in areas below the site of fracture (Fig. 15). With flaccid paralysis of the lower extremities suitable braces often permit the patient to walk with the aid of crutches. If any motor fibres remain, there is sometimes a surprising amount of regeneration with building up of muscle tissue in practically atrophied limbs. When this occurs, the braces may be discarded and a walking appliance substituted which permits the patient to maintain his balance and move about (Figs. 16 and 17).

Summary

ANATOMICAL differences account for dislocations and dislocation fractures in the cervical region; articular and compression fractures in dorsal; and fractured transverse processes and compression fractures of bodies in the lumbar region. A simple method of treatment which has been particularly successful in compression fractures of lower dorsal and lumbar compression fractures is described.

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The Injection Treatment of Hernia

—*An Evaluation Based on Five Years' Experience*—

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THE term "injection treatment of hernia," calls to mind the old outlawed paraffin plug method of treating hernia, whereas the modern injection method is based solely on the production of retaining scar tissue, while the hernia is being continuously held in place; fundamentally, the modus operandi of surgical cure.* Surgical repair requires certain qualifications, while the injection method may seem to permit anyone to at-

* From the Outpatient Department of the Division of Surgery of Northwestern University Medical School.

tempt it, since it is an office and not a hospital procedure. This alone does not seem to be a logical basis for criticism or rejection of the method. Rather the criticism should be directed toward those who attempt the procedure without proper instruction and experience.

It is certainly well-established that the injection treatment should not be used in all cases, and should not be viewed as a hypodermic injection to be carried out casually by the inexperienced. However, a comparison of the statistics presented from such institutions as the University of Minnesota,[1] shows a uniformity of agreement of the safety of the method (in proper hands)—a recurrent rate over a period of four to six years in all types of cases of 17%, which compares very favorably with surgical recurrent rate and is certainly a less expensive and safer way of handling such cases. It is well to point out that where recurrences do occur the hernia is invariably smaller than the original. Unfortunately there seems to be a wide difference of opinion as to the recurrent rate after surgical repair.*

This is due, no doubt, to the fact that many patients after a surgical recurrence do not inform the surgeon who operated upon them of the recurrence, because they either fear a repetition of the procedure or they go elsewhere feeling that the work was poorly done. With reference to the injection method, we find the literature filled with conflicting reports which tend to support the respective views of their proponents. For example, Rice,[2] of Minneapolis, reported that he had a 97% cure by the injection treatment, whereas, Burdick and Coley,[3] of New York, stated in their report a few months ago that they had about an 87% recurrence. In addition to all these facts, it is wise to state that the method is not entirely without danger as I have heard of several fatalities following the use of this procedure in different individuals. In each case, however, it has been definitely proved that the procedure employed was improperly carried out by one unfamiliar with the method. One further observation which I wish to make is that some criticism has been leveled at this treatment because of the claim that it is impossible to inject the area accurately. However, I find that in cases where methylene blue is injected and the patient is subsequently operated upon the methylene blue has been deposited accurately in the area for which it was intended, and it might be added in the case of inguinal hernia it has been seen to travel along the entire canal although the greatest concentration was found at the site injected.

As the detailed technique has been described in a previous report[4] it will not be discussed here other than to state that a proper** and well-fitted truss and a careful selection of cases bearing in mind all contra-indications are as important as the technique itself if good results are to be obtained.

The solutions used in this series of cases are, after extensive preliminary research on laboratory animals:[4]

Thuja solution containing phenol 30 cc.; grain alcohol 15; Lloyd's specific tincture of Thuja 15.

Tannic acid solution* consisting of: grain alcohol 100; bensyl alcohol 3%; thymol 0.5%.

After reviewing our records, which include those of both my private cases and those treated at Northwestern's outpatient department, I wish to submit the following statistical analysis. Before so doing it would seem wise to clarify our findings by making the following general statements. No case is here considered who has not been discharged as cured for at least six months. No case is included who has not been re-examined within at least six months. The cases here reported upon were for the greater part not especially selected cases, as only during the past year have we selected our cases more carefully. The only cases ruled out for this treatment were those in whom a truss would not hold the hernia continuously reduced (excepting, of course, the other contra-indications) and incisional or umbilical herniae in which cases only those with very small defects were attempted. The age range was from two to 90 years, and my oldest case from the standpoint of discharge is five years. One further word should be added, namely, that we wish to admit in speaking of indirect and direct inguinal hernias that it is impossible to be positive which type exists on examination alone. While we admit that this is a controversial statement we believe that even those who are most positive of their ability to differentiate a direct from an indirect inguinal hernia are frequently mistaken in their diagnosis when the case is subsequently operated upon.

The total number of cases examined with hernia was 750; of these, one-third were referred to surgery and aside from those to be reported on, the remainder did not return after truss-fittings or could not be satisfactorily followed up after treatment or are too recent to include in this report.**

For purposes of analysis, I have arbitrarily divided our cases into those over 50 years of age and those under 50 years of age. There were 133 hernias treated in 108 patients over 50 years of age, of which 100 were in the male and eight in the female.

They were divided as follows: 76 indirect inguinal with 13 recurrences; 40 direct inguinal with eight recurrence; 11 recurrent inguinal after surgical repair with two recurrences; two incisional with one recurrence; four umbilical with two recurrences; giving a combined recurrent rate of 20% in all cases over 50 years of age.

The second group being under 50 years of age gave us the following results:

There were 124 herniae treated in 94 patients of which 91 were in the male and three in the female. They were divided as follows: 71 indirect

* Another reason for the inaccuracy of statistics on surgical recurrences is the fact that in many states, including Illinois, the Workmens' Compensation Act provides that the employee has only 12 months' time after the date of the last payment in connection with the surgical operation in which to file a claim for a surgical recurrence. Obviously any record of recurrence based on only a one-year period is extremely inaccurate. As BURDICK, GILLESPIE, and HIGGINBOTHAM report, in a series of 975 herniotomies one-third of their recurrences appeared after two years (Fascil Suture Operation for Hernia—*Ann. Surg.*, Vol. 106, p. 333-343, September, 1937).

** Insufficient emphasis has been placed upon the necessity of a proper type of truss properly fitted, in previous reports.

* A solution of this type used extensively by us is Proliferol.

** The statistical date here is from a review of experience and records 11 months prior to the date of this publication.

inguinal with nine recurrences; 33 direct inguinal with eight recurrences; 12 recurrent inguinal after surgical repair with two recurrences; two femoral with one recurrence; giving a combined recurrent rate of 16% in all cases under 50 years of age. The average length of time since the last treatment in all cases is two years.

We feel, as a result of our experience with this method and our experimental study, that the following conclusions seem justified, even though it is obvious that many of the cases here reported on are too recent to be certain that they will remain permanently cured. The injection treatment seems reasonably safe if properly carried out, our mortality rate being nil, while the operative mortality rate has been given as 2.3[5] to 3%.[6]

Of course in considering these figures one should bear in mind that strangulated hernia (which contributes to the mortality rate with surgical repair) is not treated by this method. On the other hand, many aged individuals who are refused surgery because they are poor risks are treated by the injection method.

As for complications, we have to date not observed any more serious than a temporary swollen, painful condition of the cord, which was relieved by hot or cold applications, and no patient has been entirely incapacitated for more than one day. In our series five cases have been disabled from one to 12 hours. To date, we have not observed a hydrocele of the cord which required aspiration, and 3% developed hydrocele. They all subsided within a week or 10 days without any treatment other than local applications.

Three reactions have to date occurred where the patients complained of some abdominal pain and have exhibited marked weakness; breaking out in a cold sweat and simulating a mild degree of shock. All symptoms disappeared in an hour without treatment, except in one case which was removed to a hospital because of the relatively severe symptoms. He made an uneventful recovery and left the hospital a day later without special treatment. This case, I am inclined to believe, can be explained on an allergic basis. These complications occurred with solutions which we have since discarded.

In considering our recurrence rate, it must be remembered that a number of border-line cases which would now be refused treatment were included in our series in an attempt to evaluate the limitations of this method. Obviously where such cases are rejected the recurrent rate will be reduced.

The recurrence rate indicates that a more careful selection of cases is necessary. For example, only the very small post-operative ventral hernia should be attempted by this method, and we are also now advising surgery in all cases where the fascia and muscle structures seem to be too thin, or cases of especially large hernia. In such cases if surgery is refused by either the surgeon or patient then treatments are given to strengthen the area with the definite understanding that a control but not a cure can be accomplished. These are, therefore, put in a special class. This seems to me to offer a fairly large field for this work, especially in individuals where surgery is contra-indicated or has been tried repeatedly and failed.[6] It should be mentioned here, however, that Grace and Johnson recently reported on herniotomies in 1032 cases with a combined recurrent rate of 25% in primary inguinal hernia and 34% in recurrent inguinal herniae in patients over 50 years of age.

The following disadvantages of this type of treatment are: the long period of treatment and check up; the necessary dependence upon the patient to keep his truss in place, hence this element of uncertainty plus the patient's tendency to decide that he is cured after too few treatments. This is due to the local swelling and blocking of the exit of the hernia which is only temporary and after it subsides the hernia reappears.

The following advantages should be noted. There is no interference with the patients' occupation. It is a safer procedure and thus some hope of cure or relief is available for those where surgery cannot be used. In such cases a marked improvement in the general health and mental outlook occurs, and the patient can be made comfortable and more free from the danger of strangulation even though a truss may have to be worn part of the time, in the case of patients of advanced age.

These patients are rehabilitated and able to resume a gainful occupation. This group seems especially important to me, and includes poor surgical risks, repeated surgical recurrences, and those who refuse operation, as well as patients of advanced years.

Early in our work we felt that patients with a chronic cough should be refused this treatment, but considering the high incidence of surgical recurrence in such cases, we now feel that the injection treatment is preferable. Since recurrences are more probable in this type of case with either method it seems wise to employ a method where the recurrence is apt to be smaller than the original hernia, and the further treatment necessary does not involve another complete disabling procedure. Should the cough be especially severe these treatments are useful in controlling the hernias so that a truss can be worn safely and comfortably even though a cure of the hernia is not anticipated.

Another group which seems ideal for the injection treatment is the growing child, provided he is old enough to cooperate and remain quiet while being treated. Children under six or seven years of age while good subjects for this method are apt to require some momentary general anesthetic to permit the injection.

I might mention here, a patient age 87 who was confined to his bed for some weeks prior to the time I saw him and who had for some time prior to that had his activity very much limited, due to a large recurrent hernia with two points of exit. His hernia would come out in spite of his truss and cause severe pain, especially when seized with attacks of coughing. He had undergone four herniotomies by competent surgeons with a recurrence of a larger hernia each time, and had purchased

and had been fitted with 15 different trusses. Further surgery was refused by both the patient and the surgeon. This patient now leads an unrestricted life after 14 injections, but he must still wear his truss when he is up and about and a permanent cure was never promised him.

Last but not least, we must answer the question where do we stand when this method fails. Our experience is that where recurrences result they are invariably smaller than the originals although in rare cases, due to the reduction in size of the hernial orifice, they may be more painful. If surgery is then employed the surgical repair entails about 10 to 15 minutes additional time for dissection, and the only exception to this statement which I personally have knowledge of was a patient I operated upon some months ago who had received 12 treatments, the last one year previously, and due to the dense scar tissue the surgical repair was prolonged at least 30 minutes.

This complication is not entirely objectionable as the increased scar tissue seems to afford a stronger, thicker tissue with which to accomplish a surgical cure.

It is my opinion at this time, therefore, that this should not be looked upon as a panacea but in selected cases as an aid in attacking the problem of hernia and in other cases a method which will afford help which cannot be obtained by any other procedure. Further efforts are being made to discover more certain sclerosing agents which, if successful, may widen still further the field of usefulness for this procedure.

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Pneumonia in Industry

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INDUSTRY has made great strides in reducing morbidity rates and mortalities from injury. Much time is still lost from upper respiratory infections, the common cold and bronchial infections, and many deaths still occur from pneumonia.* The carefully planned first aid and the technically perfect surgical procedure are often defeated by a terminal pneumonia. The appearance of pneumonia too often spells the difference between just an accident and the coroner's verdict of pneumonia complicating an injury. In addition it will be noted that industry furnishes practically all the predisposing factors that the pneumococcus requires for its activity.

These predisposing factors, which operate directly by lowering the general resistance or the local resistance of the respiratory tract, are manifold. The lowering of the resistance of the respiratory tract is most important. The common cold, upper respiratory infections and bronchitis are known to precede pneumonia in about 80% of patients. Industry naturally favors the incidence and spread of these infections. Exposure to extremes of temperature, chilling, wet feet, fatigue, and close contact with fellow workmen are all operative in the spread of these diseases and their dreaded sequela pneumonia. Chilling of body surfaces and wet feet produce a vaso-constriction of the vessels of the naso-pharynx and respiratory epithelium. This local anemia renders the epithelium less resistant to the bacterial flora which normally inhabit those regions. The close contact of workmen combined with their personal lack of hygiene and perhaps that of the plant, renders contact infection very prevalent. While the disease most likely to be spread by contact is the common cold, there is always the possibility of direct transmission of the pneumococcus. Since these contact infections are droplet infections, the coughing and sneezing workman is a distinct hazard to industry. Irritating chemicals and dust may produce an active hyperemia and edema of the respiratory mucosa and interfere with its normal celiary activity. This tends to produce obstruction in the smaller bronchi, leading to focal areas of atelectases, where stagnant and infected material may accumulate and give rise to a typical pneumonic foci.

Trauma of various types may directly or indirectly lead to or be complicated by pneumonia. In direct trauma to the chest, such as from contusions, rib fractures or puncture wounds, pneumonia is always to be feared. They produce intrapulmonary hemorrhage which by obstructing small bronchi, lead to atelectasis, infection, and frequent pneumonia. Injuries to the abdominal viscera and the diaphragm tend to decrease lung expansion, thereby favoring stasis. Fractures and purulent foci distant from the lungs may produce embolic or metastatic pneumonia. In many of these cases the infecting organism is not the pneumococcus.

Postoperative pneumonia may occur in the surgical management of some minor or major traumatic accident. This is particularly true if the individual has previous heart damage and develops some degree of pulmonary congestion.

BECAUSE pneumonia is a factor in industry, industrial medicine should interest itself in eliminating predisposing factors, in the development of protective vaccination, and in spreading

* Read before the Congress of Railway Surgeons, Chicago, September 20, 1938.

the modern concepts of pneumonia and its treatment. The older classification of pneumonia into the primary and secondary types seems to be disappearing from the literature. Today pneumonia is being thought of in terms of the organism which is causing it, and of these there are many. Thirty-two types of the pneumococcus have, up to the present, been identified. Many other organisms including streptococcus, staphylococcus, Friedländer's bacillus, as well as the viruses, may at times cause pneumonia. Typical lobar pneumonia is a term used to designate those cases with a solid consolidation. The term atypical pneumonia is applied to those cases where the consolidation is patchy and the physical findings are less evident. The atypical pneumonias are most frequently observed in the extremes of life, in cases complicating other diseases, trauma, surgery, or chemical irritation of the bronchial tree. Most pneumonias caused by organisms other than the pneumococcus are of the atypical type. Among the various types of pneumococcus, Type III seems particularly prone to produce an irregular atypical pneumonia.

The initial pathology in pneumonia is probably in the bronchi. Here the organisms penetrate the mucosa and enter the lymphatics located in the fibrous septa. They set up a peribronchial infection which gradually travels to the periphery of the lung and to the alveoli. In the alveoli the organisms set up an exudative reaction. The alveolar spaces become filled with an exudate containing the infecting organism. The amount of consolidation and its distribution depend on the extent and type of spread along the bronchi.

This consolidation produces serious derangment in the physiology of respiration, depending to a large extent upon the amount of lung involved. First, there is a decrease in the available alveolar surface; second, there is a reduction in the amount of blood passing through the consolidated area; third, the blood that passes through the affected area fails to become oxygenated, and fourth, the edema present in large areas of the lung not consolidated, prevents normal diffusion of oxygen and carbon dioxide. These factors combine to produce an anoxic type of anoxia. The anoxia, if mild, expresses itself as dyspnea. If more severe there will be a cyanosis due to the accumulation of reduced hemoglobin in the peripheral blood. Finally, there occurs a depression of the medullary centers, with a resulting peripheral vascular failure. Restlessness, delirium and coma may also be an expression of anoxia. Along with the anoxia, there is a retention of carbondioxide in the blood stream, with a resultant decrease in the alkali reserve and loss of chlorides by way of the kidneys. In addition the increase in blood carbon dioxide tends to accelerate the respiration and increase dyspnea.

As a result of the active infectious process in the lung, varying degrees of toxemia develop. This manifests itself in many ways. First, fever develops which is associated with sweating and the loss of chlorides; second, because of the sweats and loss of chlorides, serious disturbances occur in the water and mineral balance; third, the toxemia depresses the cortical and medullary centers, producing eventually a peripheral vascular failure, with vaso-dilatation and falling blood pressure; fourth, a marked increase occurs in the metabolic rate which leads to a destruction of body tissues and possibly to the accumulation of ketone bodies in the blood stream.

Bacteremia occurs in about one-third of the cases. The mortality rate and distant metastases parallel quite accurately the cases of bacteremia.

Consideration of the pathologic physiology resulting from pneumonia suggests two possible therapeutic approaches. The most direct and specific method should direct itself against the infection. Patients who recover from pneumonia do so because they have been able to build up definite immune bodies, which have the effect of rendering the pneumococcus more easily destructible, and of neutralizing their toxic effects. This fact suggests that if these immune bodies could be preformed in some other animal and then administered, they would facilitate the destruction of the pneumococcus. This would have two salutary effects; namely, the early termination of the active infection, and the protection of the body against large and overwhelming doses of the toxins, which in themselves may be sufficient to break down the individuals' own defensive mechanisms. Anti-pneumococcus serum supplies these immune substances and is therefore a specific form of therapy directed against the specific infecting organism.

The other important therapeutic measure is directed against relieving anoxia which is an inevitable concomitant of the pathology in the lung. The decrease in the available functional alveoli leads to a decrease in the vital capacity of the lungs. Since oxygen absorption is dependent upon two factors, the partial pressure of the oxygen in the alveolar air and the available healthy alveolar surface, it is evident that when the vital capacity is decreased the partial pressure of the oxygen must be increased or else the blood will show a deficiency in oxygen. Oxygen therapy supplies this increase in the partial pressure of oxygen and tends to prevent anoxia.

Homologous anti-pneumococcus serum is the one measure which offers any hope of striking directly at the infection. Since the serum is specific for each type of pneumococcus, the whole treatment is predicated upon an accurate diagnosis of the causative type of pneumococcus. This can now be done rapidly and quite accurately by the Neufeld typing method. This method is dependent upon the fact that homologous serum for any particular type of pneumococcus contains a capsule swelling antibody. This antibody, when it comes in contact with its own specific type of pneumococcus, whether it be from sputum, peritoneal exudate, lung puncture or culture causes the capsule to swell. Technicians can be readily trained to determine accurately the type of pneumococcus in sputum specimens. Such trained technicians should be placed at various centers throughout the state and physicians should be en-

couraged to think of pneumonia only in terms of the infecting organism. They should know that over an extended period of time, experience has shown that Types I, III, II, VII, VIII, and IV will be most frequently met with, but that certain seasons or years may show a preponderance of some type or types. Furthermore, the physician should know that Types II, III, XV and XXIII over an extended period are likely to carry a high mortality rate, but that during some seasons other types may assume a particularly virulent character and will consequently require more intensive serum therapy. The exact mechanism by which anti-pneumococcus serum influences the infection is not known. It would seem to act by virtue of certain antibodies which neutralize specific pneumococcus toxins. It probably also acts by affecting the pneumococcus in such a way that leucocytes and other bacterial protective mechanisms of the body are able to function. At any rate it is certain that the serum must penetrate into the infected area if it is to be of any value. For that reason it should be given early and within a short period of time. If the infected area of a lung is tightly consolidated and has its blood supply markedly curtailed, there may be only a small amount of anti-pneumococcus serum actually reaching the infected area. Such a patient may show little response to serum therapy. Very large amounts of serum in these cases may help where the ordinary dosage fails. On the other hand the patient whose body defenses are already overwhelmed by the toxemia, will not respond to serum therapy even though it reach the focus in abundance. It is for this reason that serum so often fails in those cases where treatment has been delayed.

Realizing the objects of serum therapy; first, to affect the local pneumonic area; second, to prevent spread to other areas; third, to prevent or overcome bacteremia, it becomes obvious that it should be administered in sufficient amounts, early, and within a short period of time. Every hour that is lost affects the ultimate result adversely.

The dosage of anti-pneumococcus serum depends upon such factors as the day of the disease, extent of lung involvment, degree of toxemia and anoxia, presence or absence of bacteremia and the causative type of pneumococcus. In general the earlier the disease, the less serum required, although this depends upon how sick the patient appears. Extensive lung involvment, bacteremia, anoxia, and toxemia require more serum. Type II infectious cases usually require about twice as much as Type I. The minimal effective dosage is about 100,000 units given over a period of four to six hours, although one should not hesitate to give much larger doses when indicated. Adequate serum administration is indicated by marked improvement in the general condition of the patient and a drop in temperature. If these do not occur in 24 hours, more serum should be given. Agglutination of the specific pneumococcus, using the patient's serum and the Francis skin test can hardly be done without the aid of a skilled personnel.

In using anti-pneumococcus serum the danger of anaphylaxis can be largely circumvented by a careful allergic history together with the usual skin tests, conjunctival tests and in the case of rabbit serum, the blood pressure test. Recent work with rabbit serum shows promise of eliminating some of the anaphylactic reactions, partly because of the smaller protein molecule and partly because it can be more effectively concentrated.

THE prevention or treatment of anoxia is of great importance. It should be considered far more important to prevent anoxia, than to attempt to overcome it. This can only be accomplished by the early use of oxygen. It would not be amiss to employ oxygen as soon as the diagnosis is made, purely as a prophylactic measure. Certainly the pathology in the lung points directly toward an anoxia. If not used at once the faintest indication of cyanosis should be a sufficient reason for its use. The nasal catheter method is a simple and entirely satisfactory way of administering oxygen. Oxygen should be delivered at a rate of 6 liters per minute, and in a concentration of 50%. This will increase the partial pressure of oxygen in the alveolar air from the normal 100 mm. of mercury to approximately 380 mm. of mercury. The increase in alveolar oxygen and blood oxygen gradient will considerably augment the blood oxygen and prevent anoxia. Once oxygen has been started it should be continued until the patient shows distinct signs of recovery.

Oxygen tents and oxygen chambers are excellent but expensive methods of administering oxygen. In addition, they require more careful watching and skillful operation.

Other therapeutic measures will be needed only to the extent that the infection and anoxia are not controlled. They are not specific but tend to correct some of the general physiologic functions that are being disturbed by the toxemia and anoxia. Thus to counterbalance the effect of the increased metabolic rate, a high caloric diet should be given. This may be largely made up of liquids and concentrated sugar and carbohydrate dishes. The daily caloric intake should be about 3500 calories.

The fluid and mineral balance may be preserved by normal saline or saline and glucose given in such amounts that the total fluid intake will be about 4,000 cc. a day.

Sleeplessness may be overcome by small doses of morphine at night. Restlessness and delirium are best treated with some of the barbiturates.

Peripheral vascular failure with its falling blood pressure is best managed by intravenous administration of 25 to 50% glucose. Adrenalin and caffeine may be of some value.

AN ATTEMPT has been made to show that pneumonia is an industrial problem; that pneumonia should be thought of in terms of the infecting organism; that its symptoms arise from the infection and anoxia; that serum therapy is directed against the infection, and oxygen therapy

against the anoxia. If and when these two factors can be controlled, pneumonia can be added to the list of conquered diseases.

Discussion:

DR. JERRY J. KEARNS, Chicago: As Dr. O'Brien has said, the conception of pneumonia should be changed from that of anatomic to that of bacteriological. The reasons for this are that one is able to more intelligently treat the disease and also better able to offer an intelligent prognosis. Attempts have been made by men in laboratories to correlate the virulence of the organism and the prognosis. It was thought that if the organism wa sof low virulence the pneumonia would be central; if the virulence were greater the type of lesions would be bronchial, and in increased virulence lobar pneumonia, and in marked virulence a septicemia. This work added little to the information of the clinician. However, the work of the modern bacteriologist and immunologist has contributed something in the direction that the clinician was seeking for a considerable time, namely the classification of pneumonia according to the bacteriology. This helps, for example, in prognosis, for if the organism is found to be the Friedländer's bacillus the possibilities of death are great; if the organism is Type III pneumococcus, the prognosis would be that the patient had a 50% chance to live; if it is Type I, there is an excellent serum on the market which gives excellent therapeutic results. If the organism is the hemolytic streptococcus, for example, the consequences are usually very serious, while if it is of the treptococcus viridans type, in all probability the individual will survive.

Now, in addition to the ability to decide upon the proper treatment and the prognosis, we now can anticipate complications. The influenza organism causes not infrequently immediately an empyema or later on a bronchiectasis and after many years an encephalitis. The hemolytic streptococcus type may be complicated by either lung abscess or empyema and occasionally by bronchiectasis.

I should like, in addition to what I have said, to add a word about pneumonia as a result of oil. Lipiodol causes no reaction, while codliver oil causes fibrosis of the lung and I want you to keep in mind the ill effects of nasal sprays and drops. These oils and sprays may result in chronic interstitial pneumonia, causing marked fibrosis and narrowing and even destruction of the acinar epithelium with a resulting limitation of the acinar surface area.

In conclusion I should like to remind you that the pneumococci, for example, may appear in more than one type in a given case and if Type I is found and adequate serum is given and the patient shows no signs of progress, it is well to look for another type of pneumococcus. We have had experience of that sort. We have had a laboratory diagnosis of Type I and at postmortem found Type VIII. This means that there is more than one type present.

In addition to this there is a possibility, of course, of immunization of an individual in industry by immunizing him for the eight types. A man may be immunized against Type I actively or passively, but this immunization is specific for the type anda lso it is not a permanent immunization.

Dr. John P. Kaster

DR. JOHN P. KASTER, one of the outstanding physicians of the middle west, died at Wichita, Kansas, December 13, 1938. A heart ailment was given as the cause of death. DR. KASTER served as Chief Surgeon for the eastern lines of the Santa Fe, and was in charge of hospitalization in the Santa Fe units in this area, for more than 40 years.

He observed his eighty-first birthday last October. It was observed in line of duty and he did not take time out for a celebration of any kind. Early in the morning of his birthday date he went to Mulvane and other points to inspect hospitals.

DR. KASTER had maintained his office in the Santa Fe hospital, on East Sixth, for the last 41 years. From there he supervised the operation of Santa Fe hospitals in six states, Kansas, Oklahoma, Nebraska, Missouri, Illinois and Iowa. During the 54 years he had been in the medical service on the Santa Fe he had supervised hundreds of thousands of cases in the hospitals of the railway system.

In the more than half a century he practiced medicine his counsel and advice were sought by physicians all over the country. He was never too busy with his own work to spare time to give assistance to fellow workers in the medical profession.

He was born in Burlington, Iowa, October 7, 1857. Following graduation from Rush Medical school in Chicago he settled in his home town, where he practiced for a few years. In 1884 he became connected with the medical staff of the Santa Fe. His first assignment was at Albuquerque, N. M. He was appointed Chief Surgeon in 1897, at which time he moved to Topeka.

In The State Journal's fiftieth anniversary edition in 1935, DR. KASTER was referred to as the "Dean of American railroad surgery." He held his position with dignity and had the esteem of past and present officials of both his own company and others.

He has been honored, in appreciation of his service, several times. When the Topeka hospital opened its new unit in 1931 DR. KASTER's portrait in oil, painted by the later George M. Stone, was unveiled in the foyer and he was guest of honor during the all-day open house.

Again, in October, 1935, he was honor guest at the banquet of the Santa Fe Medical and Surgical Society in Topeka, this being the occasion of a meeting of the Society and the celebration of DR. KASTER's completion of 50 years in railway surgery. In response to the sentiment: "The Chief from a Local Sugeon's Viewpoint!" The following, given by DR. FRED S. CLINTON, of Tulsa, Oklahoma, expressed the unanimous tribute of DR. KASTER's associates:

ON THIS epochal occasion every one here is delighted to honor our Chief in celebrating his half century milestone of progress in useful and continuous service.

"The past rises before me like a mighty dream. More than two score years ago found many of those gathered here tonight on the benches of the University Medical College, in Kansas City, attending the lectures of DR. KASTER. To those, and to others who have followed his leadership to this good time, he has ever been guide, philosopher and friend. No hour was too late, no night too dark or stormy, for him to respond to his professional calls or extend wise counsel. I well remember many years ago his keeping the first official appointment with me. My work was extensive and I sought to conserve every moment. I had served as his personal representative until he tendered

an official position. By wire I arranged to meet him at the hospital office in Topeka at night. I missed the first train and arrived at a late hour after walking from the station through a torrential rain. Although near midnight he received me cordially and treated me with the deference of an honored guest. My commission was received, instructions imparted, and I left within an hour with joybells ringing in my heart.

"Passing from student to official position, now let us observe the Chief from a local surgeon's viewpoint. Aside from his ability, charming and wholesome personality, the one thing which endears him to all with whom he comes in contact is his loyalty. Loyalty to every trust, both public and private; loyalty to his patients; loyalty to his family and home; loyalty to his friends; loyalty to his country; loyalty to his God!

"This man—for he is a man in every sense of the meaning of that word—overcame all the difficulties of early privation in achieving an education and attaining professional proficiency. The early recognition, adoption and development of sane and sound principles of a noble and useful profession reveal certain characteristics of our Chief. He has Christian character, clear thought, courage, confidence, clean conduct, common sense, charitable and constructive criticism. He is calm in emergencies; companionable at all times, and cooperative in all worthwhile undertakings. His fine home life and splendid professional ideals have been an inspiring and worthy precept and example. His intelligence, integrity, industry, initiative and intuition inspire individual and institutional success. These trained individuals and institutions of the medical department are but his lengthening life, light and love for service to sick and suffering humanity. But

'I would not flatter Neptune for his trident,
Or Jove for his power to thunder.'

"I believe Dr. Kaster's professional conscience prompts him to seek the truth and live it. His character is such that all men who know him respect and love him. All those who have had the benefit of his informed advice and discriminating judgment will enshrine his affectionate memory in their heart of hearts. His rigid exaction of justice and equality of opportunity invite confidence. So, my comrades, we find our Chief

" 'A statesman, yet friend to truth. Of soul sincere;
In action faithful, in honor clear;
Who broke no promise, served no private end,
Who gained no title, and who lost no friend!' "

New Books

— Review by —

Frederick W. Slobe, M.D., F.A.C.S.

THE Relation Between Injury and Disease, by Jewett V. Reed, B.S., M.D., F.A.C.S., and Charles P. Emerson, A.B., M.D., D.Sc., collaborating with E. B. Mumford, B.S., M.D., F.A.C.S. Published by The Bobbs-Merrill Company. Indianapolis.

This comprehensive work of 577 pages, based on an experience of 36 years, was undertaken by the authors to clarify the involved status of the relationship between trauma and disease. Too long have medical textbooks routinely included injuries in the etiology of many diseases by copying from their predecessors even though modern investigation, in many instances, has disproved any such connection. Contrariwise, new developments have also indicated that trauma affects certain diseases to a greater extent than heretofore believed. The two-fold purpose of this book, then, is to correct such inequities.

From time immemorial man has been inclined to ascribe his ailments to external influences partly through ignorance and partly to bolster up his ego. The coincidental connection of trauma is usually overlooked; the long period of latency of chronic diseases before they may manifest themselves in a dramatic way is not appreciated by the laity; and the *"post hoc ergo propter hoc"* fallacy is a common one.

The book is subdivided into the following chapters: The Acute Infectious Diseases; Physical and Chemical Traumata; Diseases of the Blood Building Organs; Metabolic and Deficiency Diseases; Diseases of the Heart and Blood Vessels; Diseases of the Organs of Respiration; Diseases of the Digestive Tract; Diseases of the Genito-urinary Organs; The Nervous System; Diseases and Injuries of the Bones; Diseases and Injuries of Joints; Diseases and Injuries of Muscles, Tendons and Bursae; Diseases and Injuries of the Eyes and their Adnexa; Diseases and Injuries of the Hearing Apparatus.

Some examples of interesting conclusions are: pneumonia to be considered a contusion-pneumonia should have its initial chill at least one day after the injury and the involved area should not be demonstrable on physical examination until at least two days later; if a luetic lesion appears at the site of trauma in from four to eight weeks it may be assumed that the trauma determined its location; in an individual with quiescent cerebro-spinal lues any concussion to the brain severe enough to cause unconsciousness may cause an almost immediate development of paresis; injury cannot determine the site of a tuberculous lesion but it may aggravate a local lesion or cause an exacerbation of a lesion elsewhere (but the tuberculosis does not invade the traumatized tissue); to establish a relationship between a disease and burns, the burns must be deep and extensive and the symptoms must either appear at once or during the healing period; unconsciousness from carbon monoxide must come on during exposure, so if the onset occurs after leaving the job there is no relationship; patients exposed to hydrogen cyanide either die immediately or recover completely; neither pernicious anemia nor purpura can be caused by trauma; diabetes is not caused by trauma but may be aggravated by same especially if infection intervenes (diabetes insipidus may follow severe head trauma); as to sarcoma the authors agree with Ewing's conclusion: "Present data confirm the view, long since adopted by pathologists, that a single trauma of normal tissue is incapable of producing a malignant tumor;" there is no evidence that trauma in and of itself causes or aggravates hyperthyroidism but the anxiety following the trauma may be a factor in establishing a relationship; concerning apoplexy, since an exertion causes only a momentary rise in blood pressure, the "stroke" must occur within one minute; although there is no direct connection with myocardial disease, if said disease is secondary to an infection elsewhere, a post-traumatic connection may be deduced; however, if "demonstrable evidences of cardiac failure do not immediately follow alleged strenuous exertions, no symptoms which appear later can be ascribed to those particular efforts;" the claim "cardiac disturbance due to injury" which is frequently made usually refers to instances where the trauma merely created circumstances which brought the cardiac condition to the patient's knowledge but neither caused nor aggravated the heart ailment; all patients who have suffered severe injury, all who have recently been operated upon, and all with acute bacterial endocarditis are potential cases of

embolic pulmonary infarction; 3.3% of all deaths following trauma are due to pulmonary emboli; although infection of a normal appendix cannot be caused by trauma, a previous sub-acute involvement may be reactivated by trauma; neither hemorrhoids nor rectal prolapse are ever caused by trauma or occupational strain; in connection with perforated ulcer and ruptured viscus, Pascal's law applies, "Pressure from without to enclosed fluid is transmitted equally in all directions;" therefore, no physical effort or strain can tear or rupture abdominal viscus, cyst, or abscess; however, a gastric ulcer or a normal viscus can be ruptured by trauma against the abdominal wall providing the external pressure is great enough to compress it directly and to squeeze it between the abdominal wall and vertebral column; acute orchitis never follows direct injury, nor can a strain or trauma cause or aggravate an epididymitis, although a traumatic torsion and pinching of the cord may cause confusion in the diagnosis; neither hydrocele nor varicocele are directly caused by physical strain or trauma; miscarriage may follow trauma but there should be a close time relationship,

The above are typical examples of interesting summaries in various sections of the book. Similar points of interest are noted in the discussion of neuritis, affections of the brain and spinal cord, brain tumors, brain abscess, epilepsy, bone diseases, joint ailments, back strains, muscle and tendon involvements and diseases of the eye and ear. The authors do not follow the generally accepted opinion as to location of direct hernias medial to the deep epigastric artery, feeling that it may push out directly forward at the internal ring and that it is usually acquired and due to severe strain, sudden blows, or sudden increase in intra-abdominal pressure. As to indirect hernias (arising from a persistent funicular process) the acute form following severe strains should be associated with pain, nausea, and vomiting; where this sequence does not occur it is simply an instance of a patient becoming aware of a hernia which was previously symptomless, such cases having no edema or induration, and hence, no connection with the alleged injury.

This work is almost encyclopedic in its wealth of detail; in fact, there is so much description of the clinical aspects that at times one gets the impression that the traumatic element is not the primary purpose of the discussion. However, by presenting the clinical background so clearly before discussing the traumatic connection, a very well rounded-out description is given.

So many questions continuously arise which are so well answered in this book that it is really indispensable for physicians interested in industrial medicine and surgery, attorneys who are involved in compensation and liability litigation, and insurance companies.

Congress on Industrial Health

ONE outstanding keynote of the First Annual Congress on Industrial Health, January 9 and 10, at Chicago was the insistence that industrial health is an "educational problem." This was particularly stressed by DR. DONALD M. SHAFER, Associate Consultant on the Committee of Healthful Working Conditions of the National Association of Manufacturers. DR. SHAFER said that the small manufacturer himself was the first person who had to be convinced that industrial medical service was worthwhile. "He must be shown that it is not welfare work, nor philanthropy, but 'good business'." This must be accomplished, he continued, in a way that will make the manufacturer "want to do something" about it.

"This educational program directed towards the manufacturer must be preceded by or paralleled by education of the physician," he added. "It will defeat the whole program if the man who is to bring adequate medical care and all of its savings and value is not able to fulfill his part of the program."

DR. SHAFER then emphasized that the National Association of Manufacturers, whose new program for industrial health he described, had "no desire to encroach upon the field of the private practitioner." What it does seek, he said, is recognition that "the doctor who undertakes to care for the workmen of a factory must know the potential industrial hazards of that factory's processes and materials. He must not only know therapy, he must also know prevention. He must not only know diagnosis, he must also know workmen—their sense of values, and their relations to each other and to the employer."

The Knudsen Award

FOLLOWING are the requirements and conditions governing the award of the Knudsen Plaque—which is to be given, as announced in INDUSTRIAL MEDICINE for August, 1938, (p. 517) "for the most outstanding contribution to industrial medicine:"

1. Competition is open to members of the American Association of Industrial Physicians and Surgeons only.

2. Any member who desires to be considered as a prospective candidate shall notify the committee of award not later than December 1 of any one year (except 1939) submitting a brief description of the subject of his contribution.

3. The award shall be made to the member submitting a monograph, paper or book on some phase of medicine as applied to industry, showing original research and investigation.

4. The monograph, book or paper should bear impress of bona fide originality accompanied by complete bibliography.

5. The monograph, book or paper must be submitted in typed form, three copies on paper size 8½ x 11. If book is submitted it will be considered as submitted.

6. The paper, monograph, book or resume thereof must be presented by the author at the regular meeting of the Association next succeeding to receive the award.

7. The plaque shall not be awarded to the same member more than once in five years.

8. If there is no work deemed worthy, the award will not be made in that year.

9. All papers must be in the hands of the Committee not later than March 1 of each year.

10. The award will be made to that member submitting what in the estimation of the Committee is the outstanding work as outlined in the above requirements.

These requirements and conditions were prepared by the Committee, of which DR. LOYAL A. SHOUDY, is chairman, and DR. MCIVER WOODY and DR. C. F. N. SCHRAM are the other members.

The December 1 date above mentioned does not apply to the year 1939. For this year the notification to the Committee should be made before March 1, 1939.

Industrial Medicine

Reg. U. S. Pat. Off.

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A New Year's Preamble

THE turning of the calendar to a new year has probably no more important significance than that which impels to a reckoning, a casting-up of accounts, a balancing of factors, a determination of position—applying the sextant to the elemental guiding points of life so as to renew the orientation that tells of progress and direction. And one helpful part of this process is a renewed contact with principles, meanings, and definitions.

On every basis, and along every line, industrial medicine advanced with giant strides in the year just closed. And it goes into 1939 with a momentum that ought to carry it far ere 1940 comes upon it. But in order that its inevitable growth and development in the near future may keep on the proper course—in plain terms, may not be thrown off by the increasing "social" significances which are more glamorous than sensible—it may be well to reconsider, and reaffirm, the essential meaning of industrial medicine. We therefore suggest that the following be read and thought about by all who are now *in* industrial medicine, to the end that they may bring it, as forcibly and as earnestly as may be necessary, to the attention of all the many who from without the profession are too evidently overplaying the "social," as well as the more than several who from within the profession are, from present appearances, likely to be too much impressed by the "health." A restatement, but as important as the meridian:

GENERAL economics along broad lines, and industrial economics along specific lines, have modernized to a very considerable extent the traditional concept of the duties of the employer to the employee. The indefinite generalities of the older common law are being slowly but effectively supplanted by the definite and specific obligations of the newer statutes. In the process a number of extra-contractual relations between employer and employee are being permanently superimposed upon the basic relation of the contract of employment. All of these have their origin in, and owe their existence to, the *fact* of the employment; and in all of them the employer—in one way or another, but always to an extent involving costs in addition to wages—is the party of the paying part.

The most important of these superimposed relations is that one which has been made specific by workmen's compensation legislation.

This was persuasive toward a study of medical services in industry, with the result of a considerable movement on the part of industry and the medical profession toward the organization and establishment of medical services for employees on a medical basis.

The next important superimposition, and the one of the greatest recent interest, is the addition of occupational diseases to the matters of statutory significance — which brings to the necessity of instant attention the study of, and the need for, preventive medical measures.

Industrial medicine, with its concomitants of industrial and traumatic surgery, is the field of medical practice which is developing around, and has already attained important and definite proportions in connection with, these and their attendant superimpositions.

The ultimate boundaries of the field of industrial medicine as it interests the medical profession are, therefore, the boundaries of all employment wherever and in whatever form it exists.

And the ultimate scope of the work which is to be done — and which *can* be done — only by the medical profession, is thus measured by the medical needs of the individual human being in three relations:

Medical science must be brought to bear:

1—Not only upon the employee as an individual human being,

2—but also upon him as one of the parties, and inevitably the human party, to a contract of employment,

3—and likewise upon the situation in which he, as a human being, performs his contractual duty.

These three relations involve the medical, insurance, medicolegal, occupational disease, accident prevention, hygiene and health, and physical condition factors, considered in their social, economic, administrative and managerial phases, as well as, and in addition to, their scientific phases —

and, to a lesser but growing extent, certain psychological, emotional and physical idiosyncrasies.

And all of these added phases, to the full extent of their superimposition resulting from the fact of employment, enlist medical thought and demand medical attention not alone because they concern the human being, but essentially because they concern the human being in employment—against the background of the statutory responsibility of the employer in terms of an expense which ultimately he must pay if they do not receive the medical attention which becomes necessary because of the fact of employment.

A broad field, and a broad scope—both so vast that industrial medicine cannot be a specialty in medicine or surgery, but on the contrary must consist of the application of all medical and surgical specialties to the economic situations as well as to the personal situations of the human beings who are the performing parties under their respective individual contracts of employment.

INDUSTRIAL MEDICINE, therefore, is something added to the practice of medicine—just as the need for it and the recognition of the need are added to working conditions.

If it should require a definition, it may be said that industrial medicine is the doctor-patient relation *plus,* because while it includes all of medical science which concerns the individual as a human being it also take cognizance, in terms of medical science, of the fact that this individual is subject to the influence of his work and the environment in which that work is performed.

It is industrial only in so far as it is necessary because of the work. It is medicine only in so far as the circumstances and conditions of work require its preventive or curative application.

PUT a "Whereas" in front of the foregoing and it becomes the preamble that will make any New Year's resolution concerning its elements a good one!

INDUSTRIAL HEALTH AND DISEASE

Dr. Fred W. Fitz Appointed Chicago Tribune Medical Counsellor

CHICAGO TRIBUNE announces the establishment, on January 1, of a medical service department for its employees, and the appointment of Dr. Fred W. Fitz, of Chicago, as Medical Counsellor in charge. The announcement says:

"To assist employees of *The Tribune* and their families in obtaining competent medical care and proper hospital facilities within their ability to pay, a medical counsellor has been appointed and will be established in Tribune Tower this week.

"The counsellor's services will be controlled by the Dearborn Mutual Benefit association, an employees' organization. The cost will be met by the Tribune company.

"It is not contemplated that the counsellor shou'd treat or prescribe for or become the personal physician of any employee or member of any employees' family. His services will be entirely advisory.

"Through studies and inquiry made by the welfare bureau of *The Tribune* it has become evident that hundreds of employees in various departments, with their families, are in need from time to time of unbiased medical guidance—direction to competent physicians and surgeons and proper hospital facilities.

"Many employees, of course, have medical advisers entirely satisfactory to them and their families. The service now being established is not designed for such families. Moreover, it is important to emphasize that recourse to the service of the counsellor will be entirely voluntary on the part of any employee.

"Welfare work for *Tribune* employees, starting with the establishment of a pension plan in 1911, has been broadened from time to time as opportunity for new services became apparent. For many years it has included a sick benefit plan, the services of a registered nurse and dental service, all provided by the company. More recent projects designed to help meet the problems of illness and death are group insurance, of which the Tribune company bears part of the cost, and membership of employees in the Plan for Hospital Care, payments for which are met by the employee subscribers.

"The duties of the latest addition to these welfare services, the medical counsellor, may be outlined as follows:

"1. To confer with employees who wish to consult him about their personal medical problems or those of their families.

"2. To advise, when requested, as to competent physicians in all parts of the city and suburbs and to maintain a list of such physicians, men known to possess not only skill but a high sense of honor and integrity, whose fees will be in accordance with the employee's capacity to pay.

"3. To assist in arranging for surgical procedures, hospital accommodations, etc.

"4. To act, when the emp'oyee or his family desires, as an agent between them and the physician they select. The counsellor's medical knowledge would assure a fair answer to such questions as the necessity for a proposed operation.

"5. To cooperate in assuring employees fair charges on the part of physicians, surgeons, hospitals, and nurses.

"6. When an employee so requests, to check any diagnosis brought him by the employee either by conference with the physician making it or by reference to the symptoms leading to the diagnosis.

"7. To advise on group health problems of employees, and inspect working conditions in departments of *The Tribune.*

"Dr. Fitz, who will serve them as medical counsellor, will not treat or prescribe for any employee, but will act under the control of the Dearborn Mutual Benefit association, an employees' organization. His services are to be entirely advisory."

New York State Society

THE Annual Meeting of the New York State Society of Industrial Medicine was held in Albany at the Ten Eyck Hotel November 3, 1938. The speakers were:

Mr. William J. Picard, chairman, board of standards and appeals, state department of labor, The Dust Control Problem of the State Department of Labor.

Dr. Leroy U. Gardner, Saranac Lake, The Inhibitory Action of Other Mineral in Association with Silica.

Dr. Richard Kovacs, New York, Physical Therapy in Fracture Treatment.

Dr. Joseph Buchman, New York, A Resumé of the Post-Traumatic Osteoporoses.

Dr. Edgar A. Vander Veer, Albany, was succeeded as President of the Society by Dr. Paul B. Jenkins. Dr. Gardner's article as presented at this meeting was published in INDUSTRIAL MEDICINE for December, 1938 (p. 738).

Skin Burns from Lime Dust

WORKMEN exposed to lime dust frequently suffer from skin injuries ranging from non-disabling (though painful) localized sores to serious burns over a large skin area. Such exposure is not confined to the production of lime, but is a factor in such industries as the manufacture of hydraulic cement, sand-lime brick, calcium cyanamid, fertilizers, insecticides, etc.

Skin burns of this nature are caused by unslaked lime (quicklime, burned lime, calcium oxide) and not by hydrated lime (hydrate, slaked lime, calcium hydroxide), although occasionally a commercial hydrated lime may contain a small percentage of unslaked lime sufficient to cause skin burns when exposure is great.

Lime burns are caused by the slaking of the quicklime particles in the sweat. The incidence of this trouble is always high in warm weather and comparatively rare in cold weather. Some individuals who do not perspire excessively are practically immune to it.

Wherever possible, prevention is best afforded by suppressing the quicklime dust by means of local exhaust ventilation. In situations where this is impractical the skin should be protected. Workmen in lime plants commonly smear exposed parts of the skin with grease of various kinds. Dusting plain talc powder on the skin provides a more cleanly form of protection and one described by a doctor for a large producer of lime as completely effective in the prevention of lime burns.* Unscented talc powder in bulk is readily available in the market.

Treatment should consist in removing the worker from exposure and applying mild palliative lotions or ointments. Those who suffer repeated attacks on resuming work should seek an occupation in which they do not come in contact with lime.

* PETHER, G. C.: *Brit. M.J.*, October 9, 1937, p. 702.

Industrial Health Committees

IOWA: The Iowa State Medical Society has appointed a committee on industrial health. Dr. Edward J. Harnagel, Des Moines, has been named chairman and Drs. Aldis A. Johnson, Council Bluffs, and William C. Goenne, Davenport, are members.

TEXAS: Dr. Charles M. Aves, Houston, has been appointed chairman of a new committee on industrial health of the Texas State Medical Association. Members of the committee are Drs. William P. Lowry, Wichita Falls; Ross B. Trigg, Fort Worth; George Sladczyk, Port Arthur, and Harry A. Haverlah, Palestine.

Health Hazards and the Hire of the Workingman

THE health of the working man as a matter of interest to his employer has had much more emphasis in recent times although it is decidedly not a new thought. The philosophy that employment for hire carries with it the obligation for additional compensation and care in the event of injury or impairment of health as a result of that employment is of more recent date.

Professor Bernardo Ramazzini of the University of Padua is given credit for preparing a scientific basis for consideration of industrial hygiene in his treatise on diseases of occupation, "De Morbis Artificium Diatriba," published in 1700. Dr. Harry Mock, who instituted routine free examinations of employees for a Chicago firm in 1909, states that the first physical examinations of employees were reported by Dr. Frank Fulton of Providence, Rhode Island, in 106. There seems not to have been any organized activity along those lines until the inauguration of a section on industrial hygiene by the American Public Health Association in 1914. In 1915 the United States Public Health Service organized a division of industrial hygiene and sanitation, and The National Safety Council established a section on

* Editorial in *Journal of the Indiana State Medical Association*, August, 1938.

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Dr. McNally has had 25 years of experience as specialist consultant in Toxicology. Univ. Mich., 1901-05; Univ. Ill., 1905-06; 1916-17; M.D. Rush Med. Coll., 1930; Post-grad., Vienna, 1935; at present, physician, chemist and medico-legal consultant in majority of poison murder cases today.

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by C. O. SAPPINGTON, M. D., DR. P. H.

CONSULTING INDUSTRIAL HYGIENIST

HERE, in this handy volume, is the crystallization of all the medical, medicolegal, statistical and industrial information developed from the experience of the past, in form to be of utmost usefulness in the problems of the present and the future. This is essentially a book for everyday use — not to be put on the shelf for reference, but to be kept on the desk within quick reach at all times. It is a handbook — guide — manual — of constant daily importance to physician, lawyer, hygienist, engineer, safety director, nurse, claim agent, in fact everyone interested in any phase of the occupational disease picture. The following table of contents is a preview of the subject matter.

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health service. In the same year the American Medical Association created a section on hygiene and preventive medicine.

The American Association of Industrial Physicians and Surgeons, the Association of Railway Surgeons, and other organizations, offered opportunity for contact between medical men, specializing in or having interest in certain phases of medical and surgical service in industry. A number of state departments of health established bureaus of industrial hygiene. Of these, the newly created Bureau of Industrial Hygiene of the Indiana State Board of Health, now making a survey of occupational disease in Indiana, is a very promising example. However, it has long been evident that industrial development and newer social thought present increasing problems in industrial hygiene. Recognizing this need, the American Medical Association, in 1937, created a Council on Industrial Health, to coordinate research, establish standards, assist in the interpretation of medicolegal problems, provide a clearing house for information, and stimulate interest in obtaining improved conditions through local medical organizations. Consistent with these advances, the Indiana State Medical Association takes the lead in making industrial health a part of its outstanding program on disease prevention. Industry in recent years has been striving for decentralization of manufacturing activities, and there is scarcely any community in the state which does not have some industrial plant problems. The matter, therefore, becomes of interest to all the component county medical societies and to the profession of the whole state.

THUS runs the chronicle, but the complexities of occupational disease grow even more rapidly. State legislatures within the past two years have named a considerable number of conditions as compensable industrial diseases. Some of these conditions have not been scientifically defined. Most of them require much more study, and the extent to which the average industrial exposures constitute a hazard and contribute to their etiology will require further observation.

Judicial bodies, lawyers, employers, and employees, need guidance. Finally, physicians who must protect the health of employees, treat them when ill or injured, and eventually give a fair appraisal of their disabilities, require training and access to the results of research not practicable in each industrial plant. Greater opportunities for education in the specialty are needed. Even the nomenclature is haphazard and lacking in definition. Some new terms and more definite usage are indicated. Dr. L. D. Bristol, in 1937, reported that only 13 out of 85 medical and public health schools in the United States and Canada give separate courses in industrial hygiene or industrial medicine.

The quality and quantity of medical services provided in industry is a responsibility of state and county medical associations, just as is the character of medical service provided for the public outside of industry. Hospitals share in the responsibility of care of those suffering from the effects of occupational disease and must awaken to the needs of providing facilities and trained personnel for proper care.

Medical services performed in industrial medical departments should be surveyed to determine the proper relationship between industrial medical departments and the private practice of medicine. Cooperation between the physician and the engineer are necessary in the industrial health program. Employer management needs guidance, and the insurer must be considered in the care of occupational disease.

In all of these matters the physician must take a leading part. Upon his advice measures may be instituted to safeguard industrial health. His is the responsibility to provide a fair appraisal of occupational diseases in order that they may be dealt with scientifically and in reasonableness and justice.

The Indiana State Medical Association and its officers are to be congratulated for this advanced position in promoting interest in industrial health.